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(51) INT CL[7]
G02F 1/1362 // G02F 1/1339 1/1343

(52) UK CL (Edition R)
G2F FCD F23E
G5C CA310 CA342 CHG

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(58) Field of Search
UK CL (Edition Q) G2F FCD , G5C CHG
INT CL[6] G02F 1/1339 1/1343 1/136

(74) Agent and/or Address for Service
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(54) Abstract Title
Multi-domain liquid crystal device

(57) Gate bus lines and data bus lines are arranged orthogonally on the first of two facing substrates, separated by a layer of liquid crystal, to define a plurality of pixel regions each containing a pixel electrode. A common electrode is formed on the facing substrate. Dielectric frames control the alignment direction of the molecules in the liquid crystal layer.

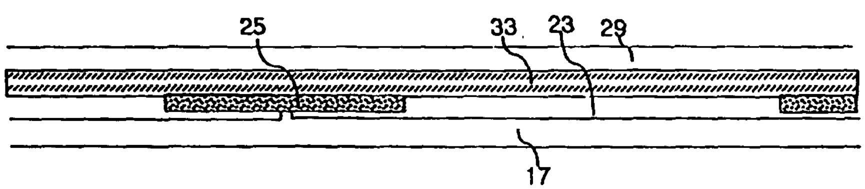
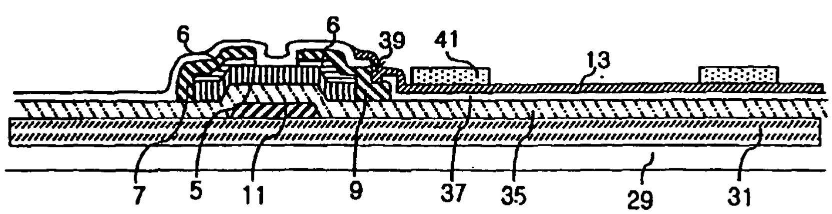


Fig. 3A



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DRAWINGS

FIG. 1

PRIOR ART

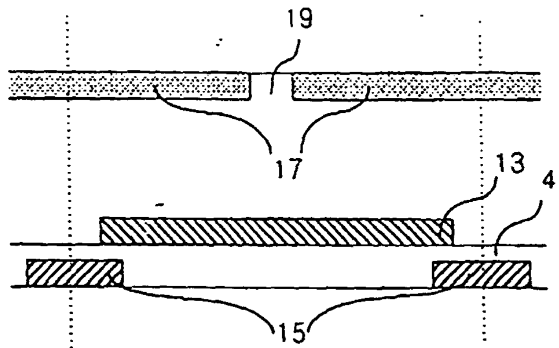
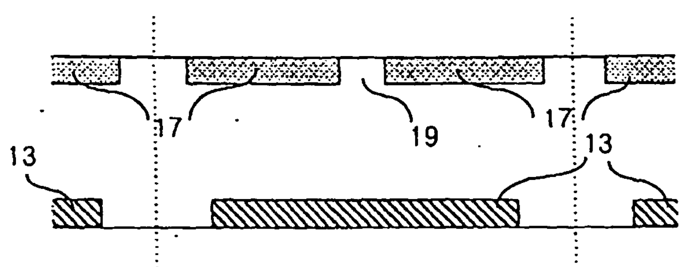


FIG. 2

PRIOR ART



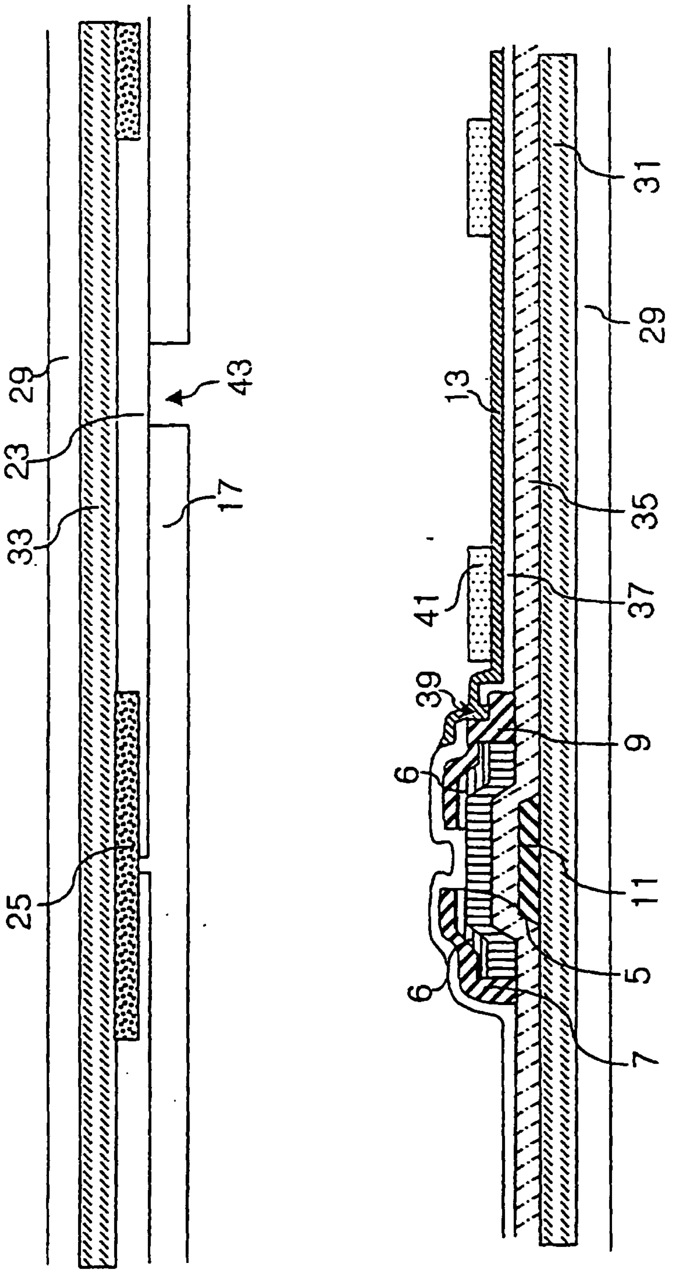


Fig. 3B

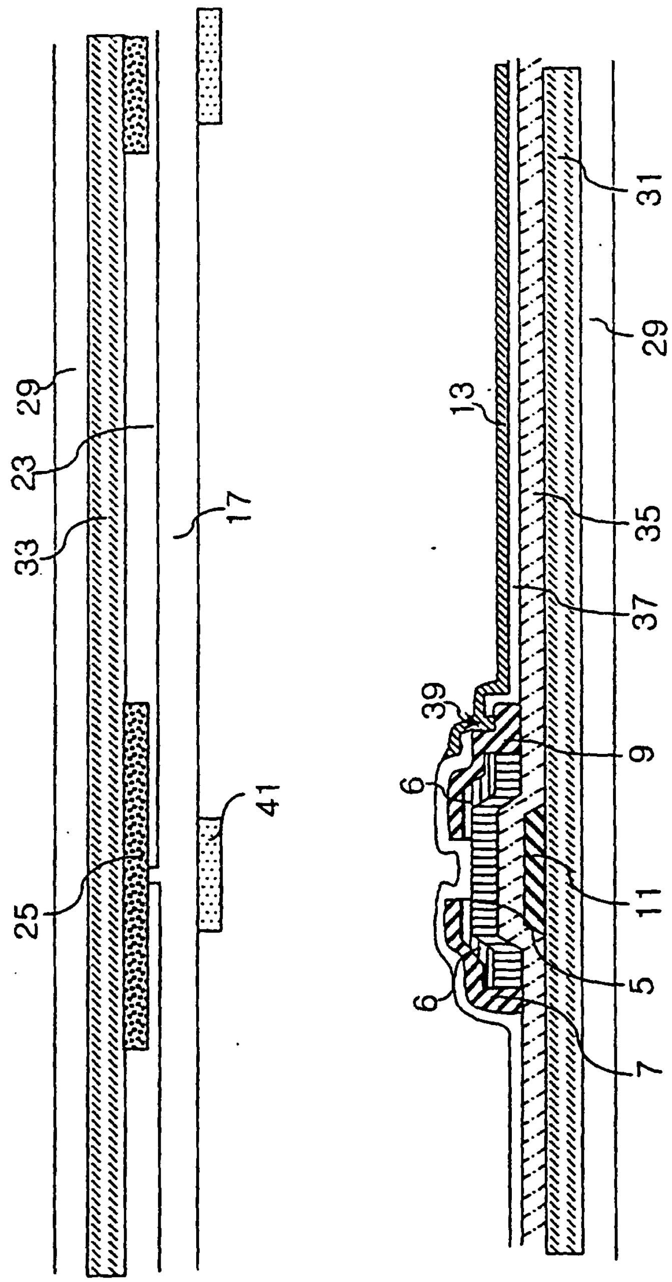


Fig. 3C

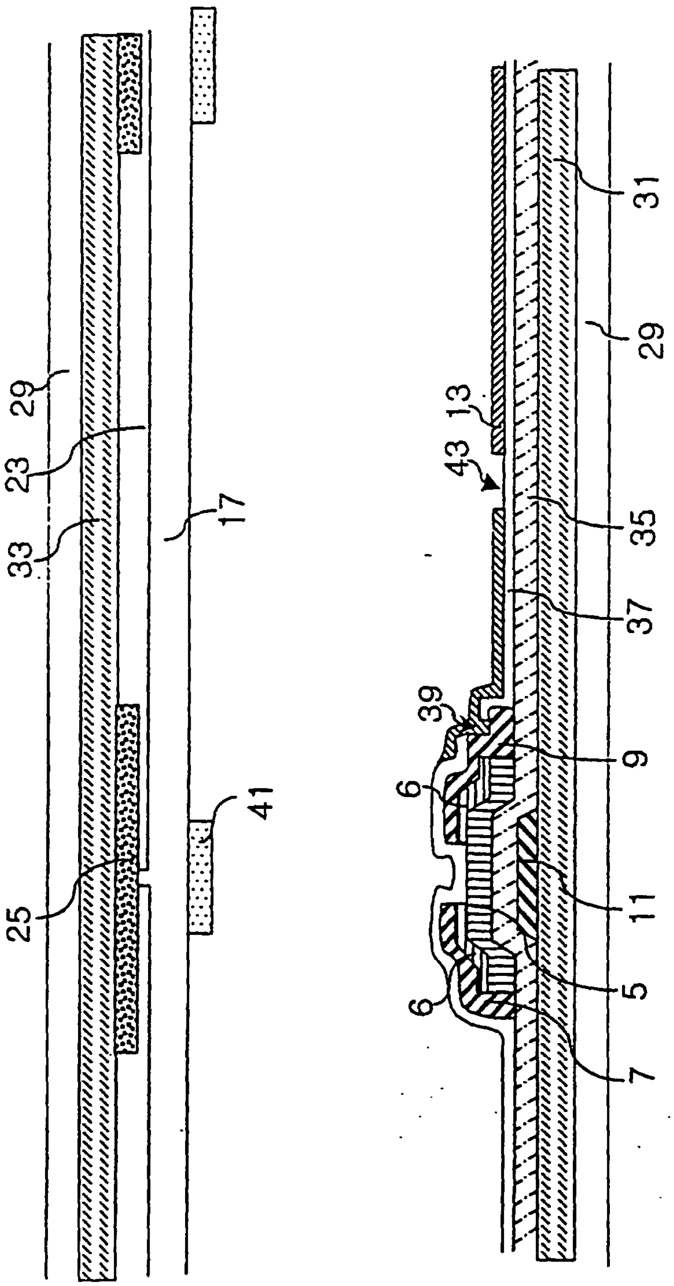


Fig. 3D

FIG. 4A

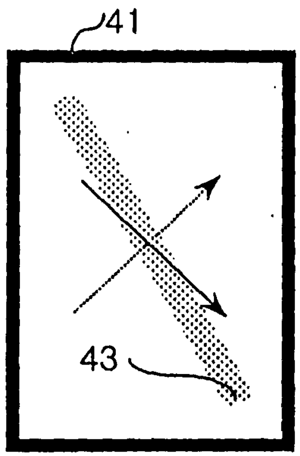


FIG. 4B

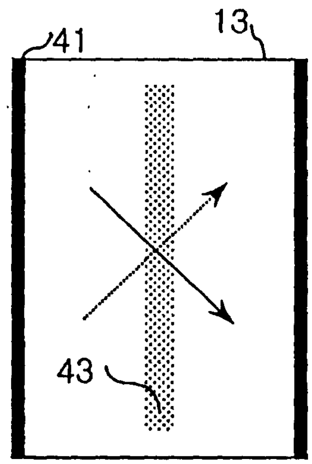
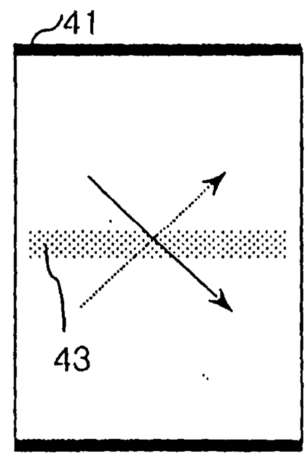


FIG. 4C



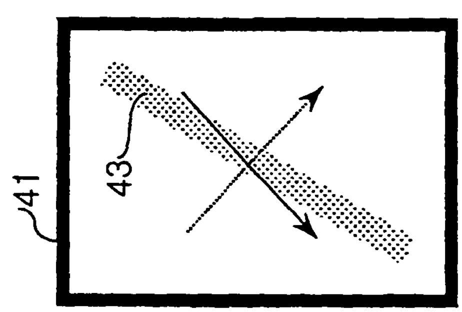


FIG. 5A

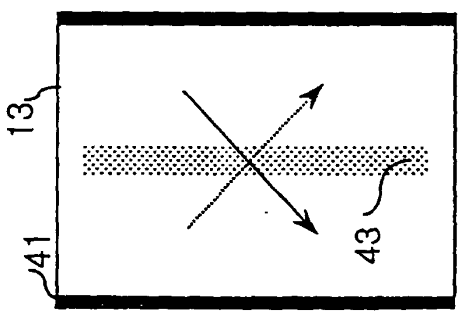


FIG. 5B

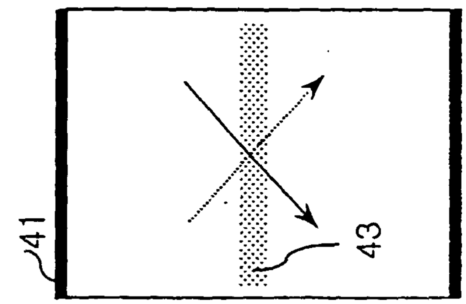


FIG. 5C

FIG. 6A

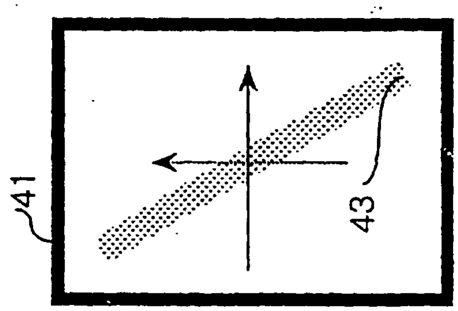


FIG. 6B

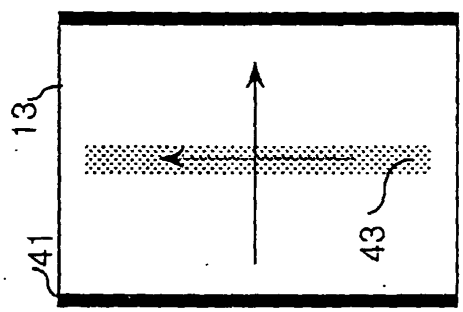


FIG. 6C

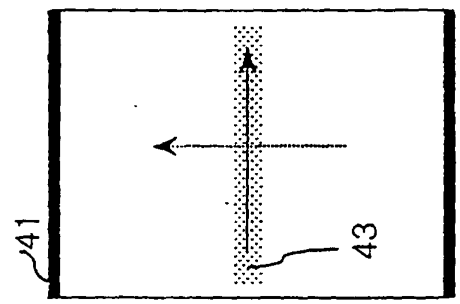


FIG. 7A

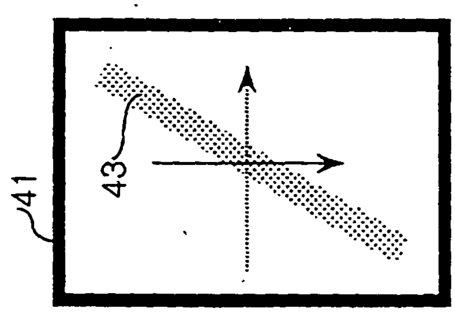


FIG. 7B

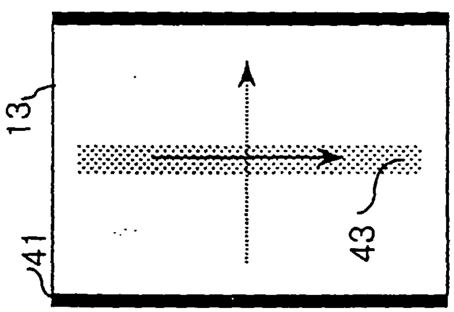


FIG. 7C

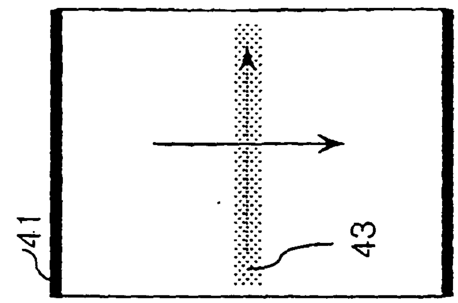


FIG. 8A

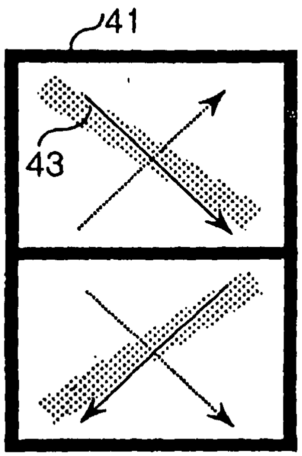


FIG. 8B

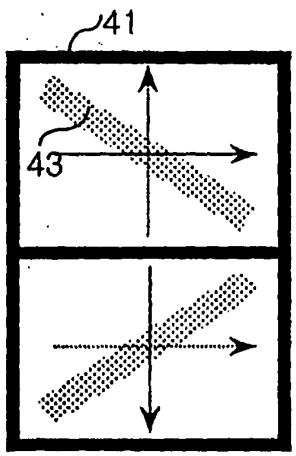
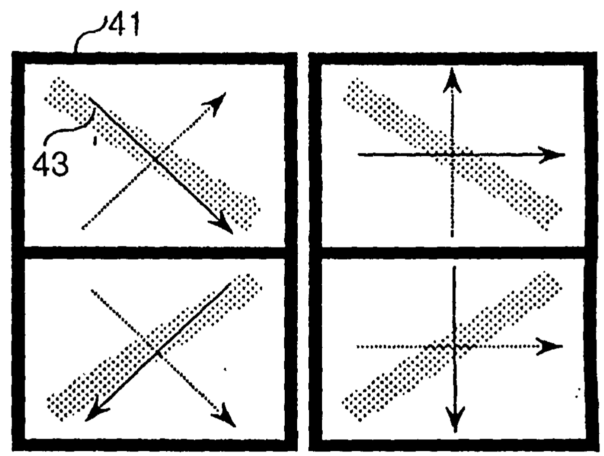


FIG. 8C



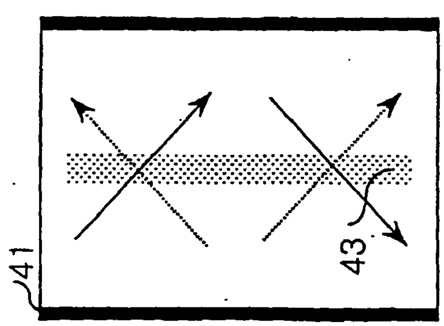


FIG. 9A

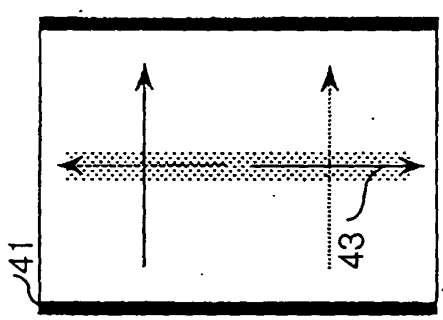


FIG. 9B

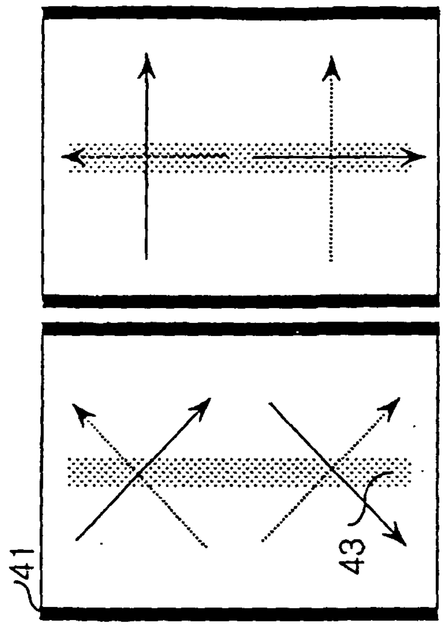


FIG. 9C

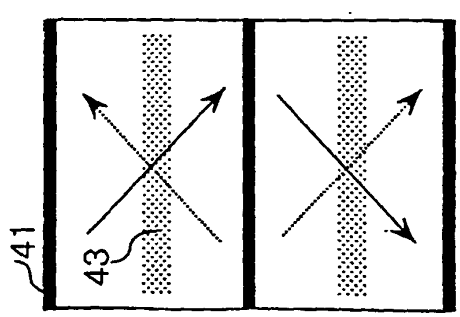


FIG. 10A

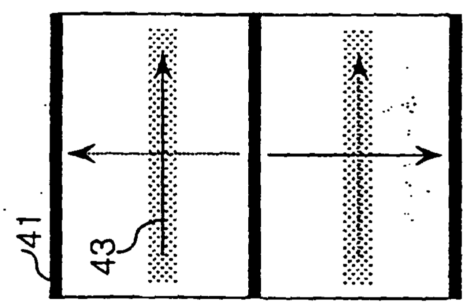


FIG. 10B

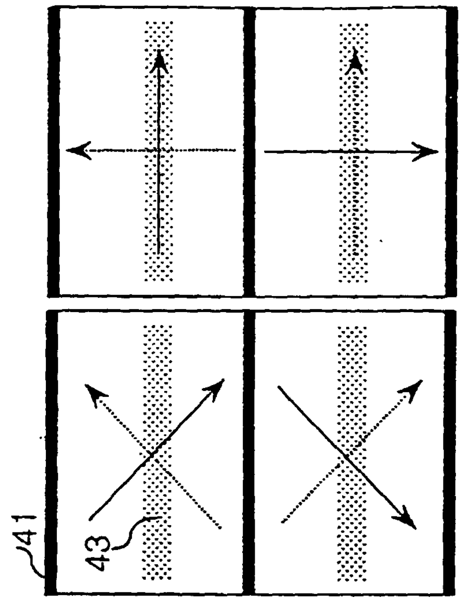


FIG. 10C

FIG. 11A

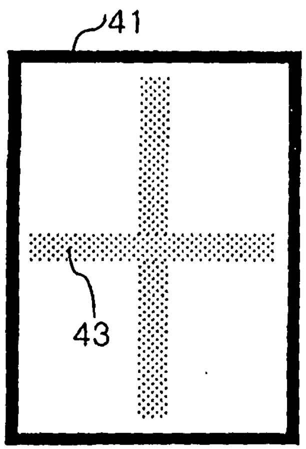


FIG. 11B

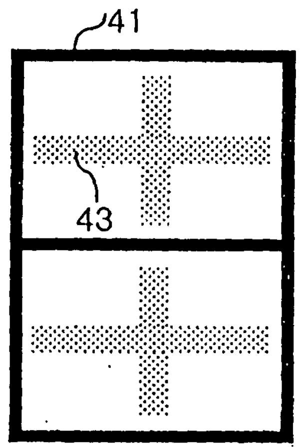


FIG. 11C

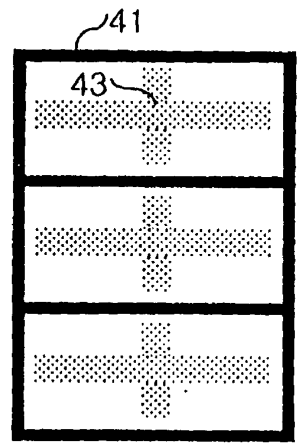


FIG. 12A

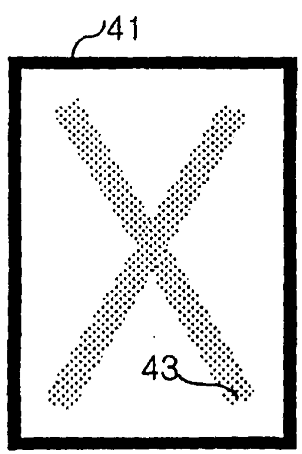


FIG. 12B

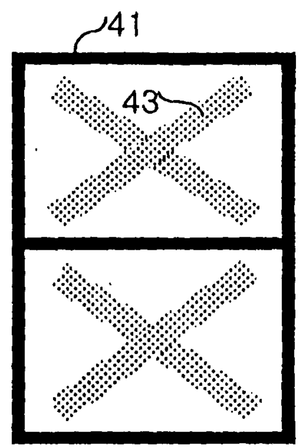


FIG. 12C

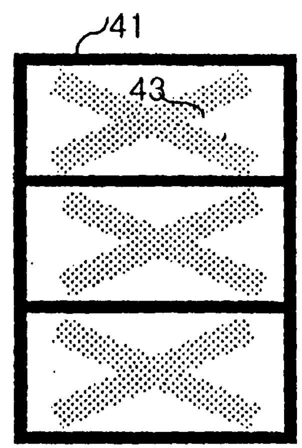


FIG. 12D

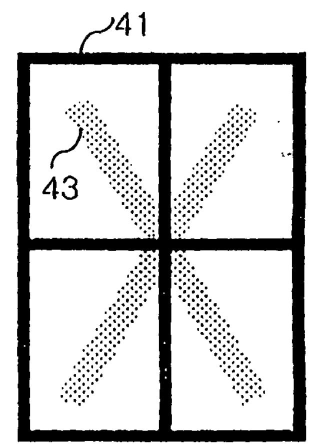


FIG. 13A

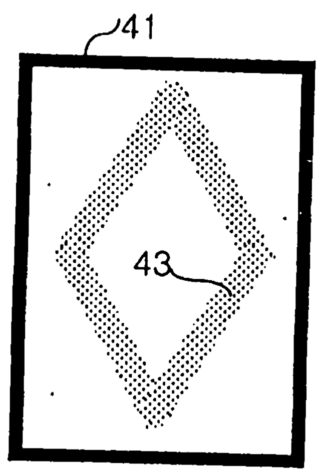


FIG. 13B

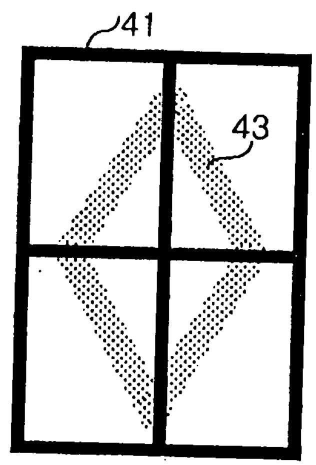


FIG. 13C

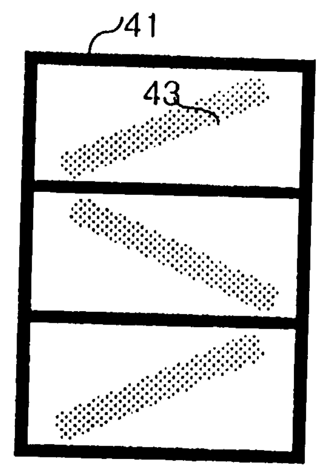


FIG. 14A

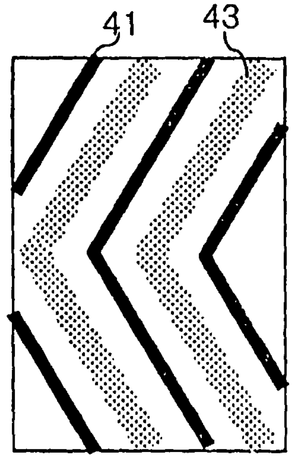


FIG. 14B

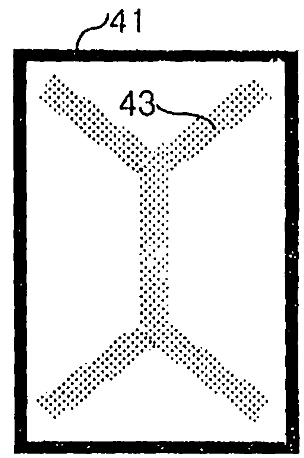
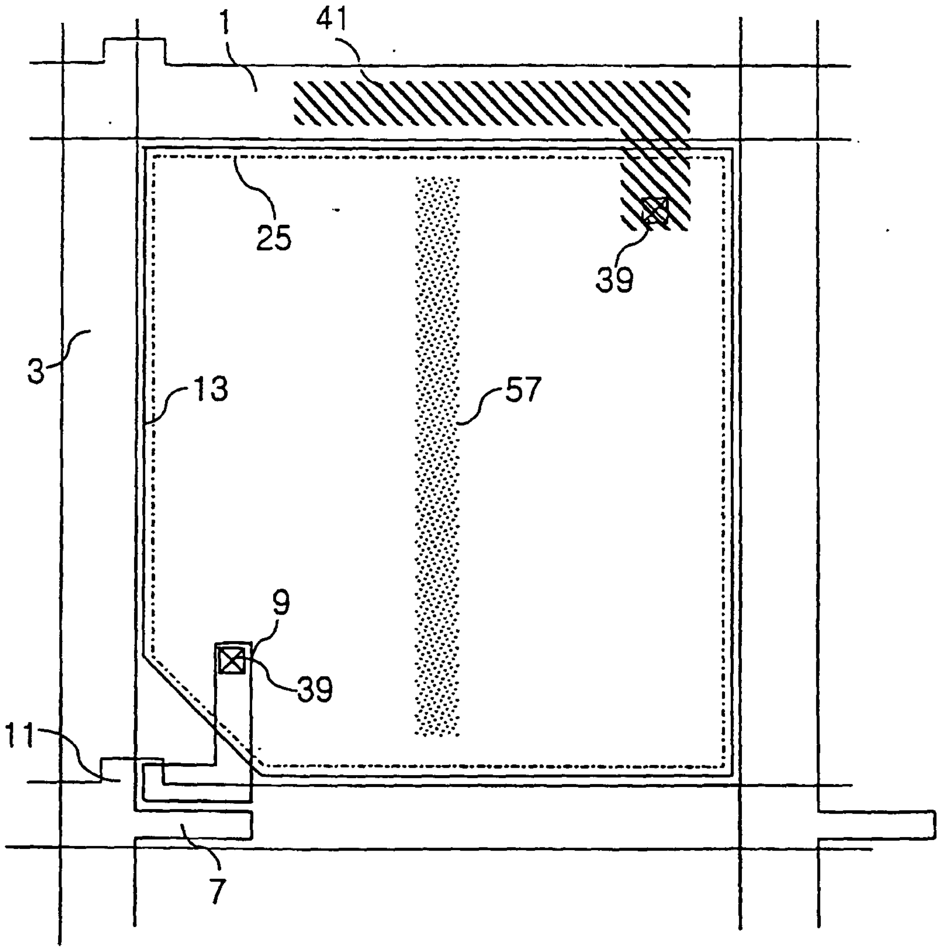


FIG. 15A



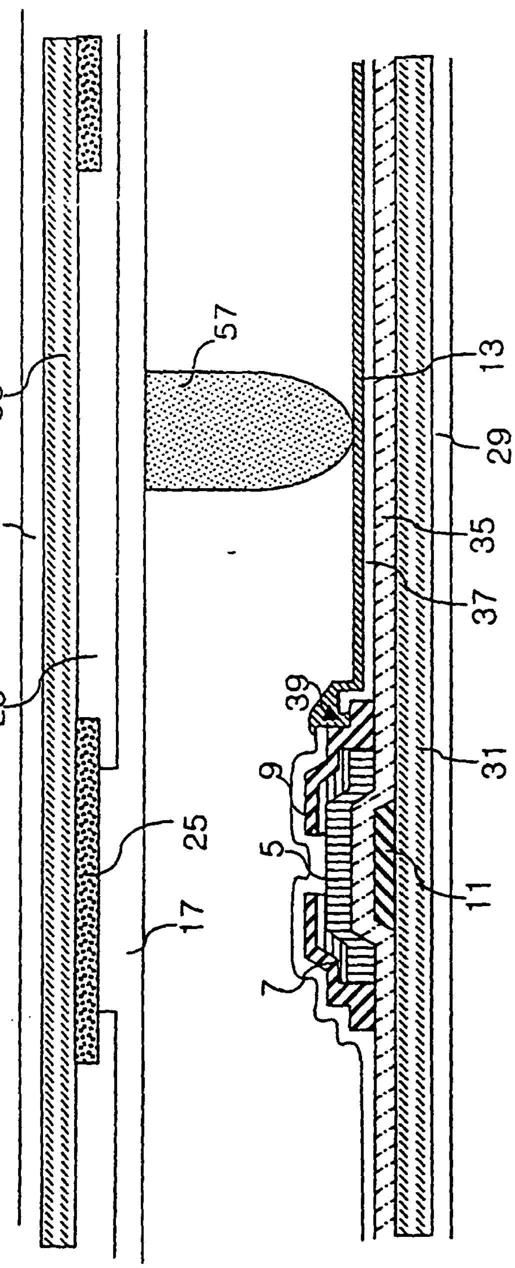
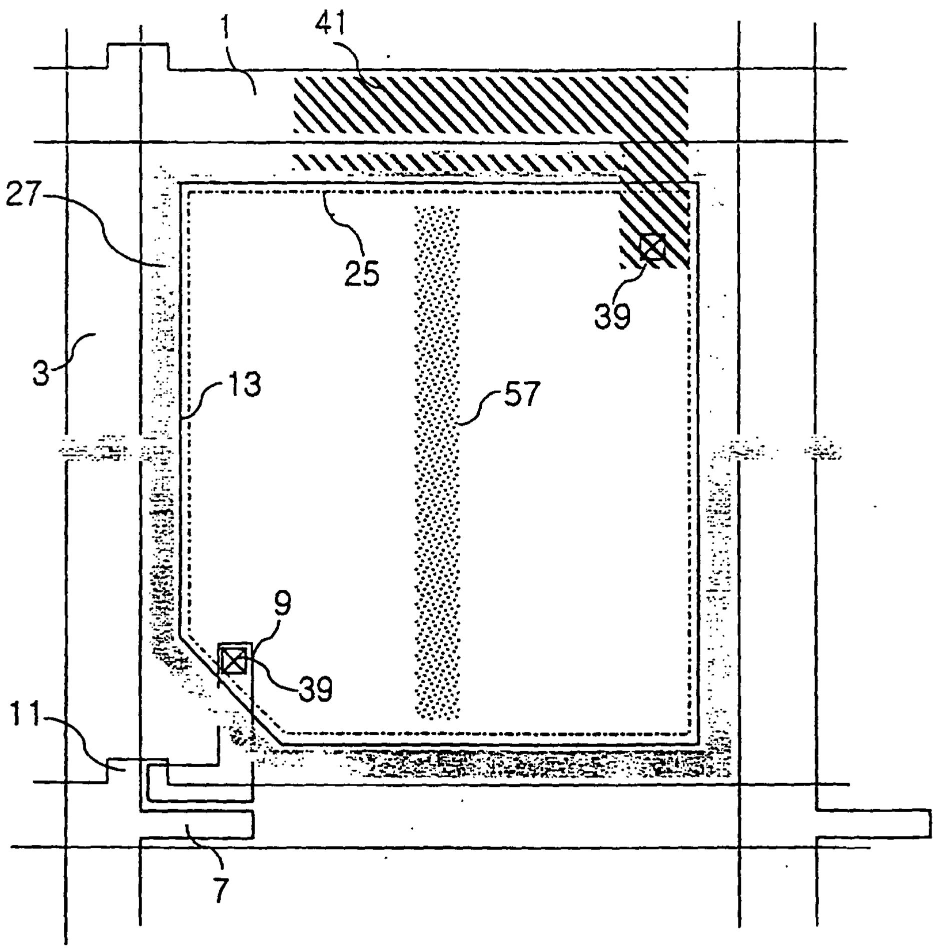


FIG. 15B

FIG. 16A



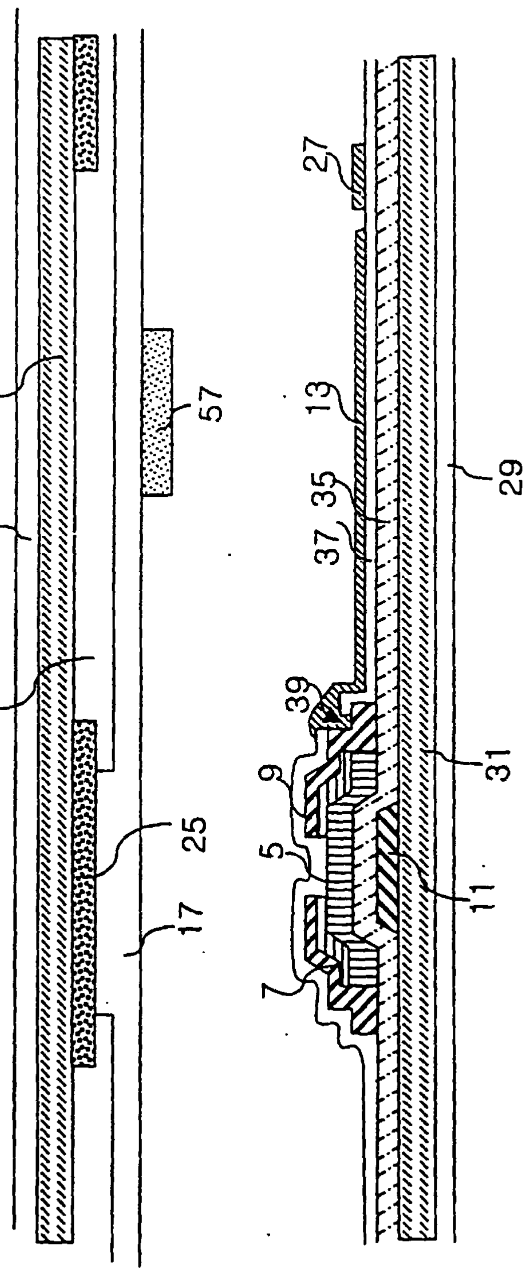


FIG. 16B

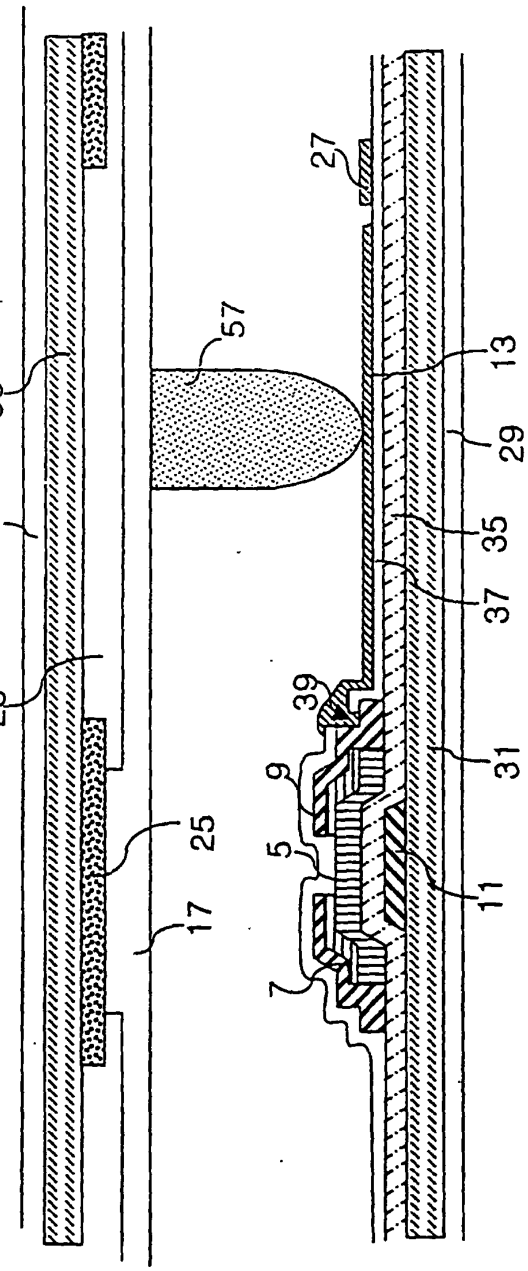


FIG. 16C

FIG. 17A

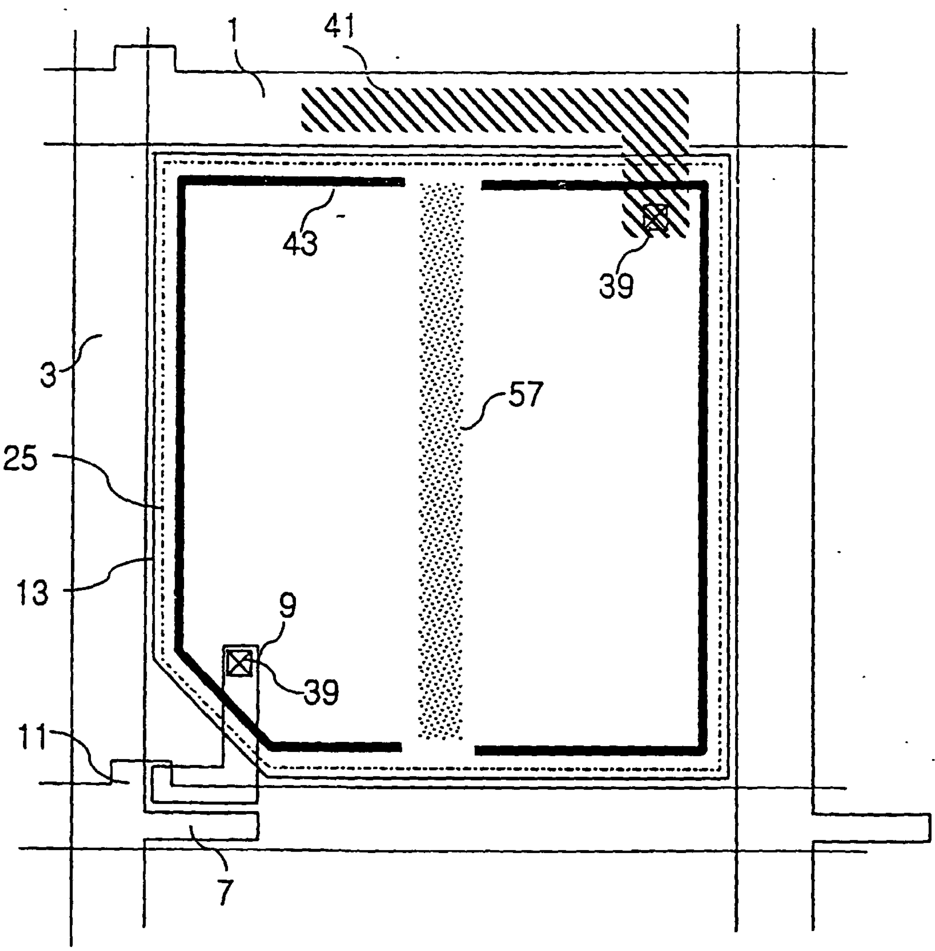
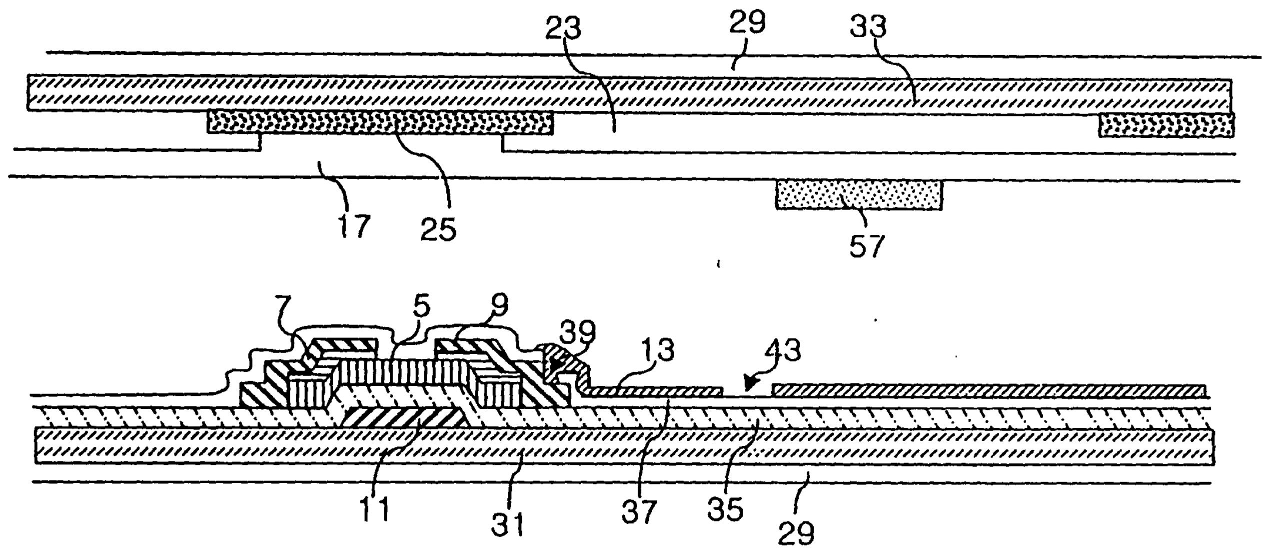


FIG . 17B



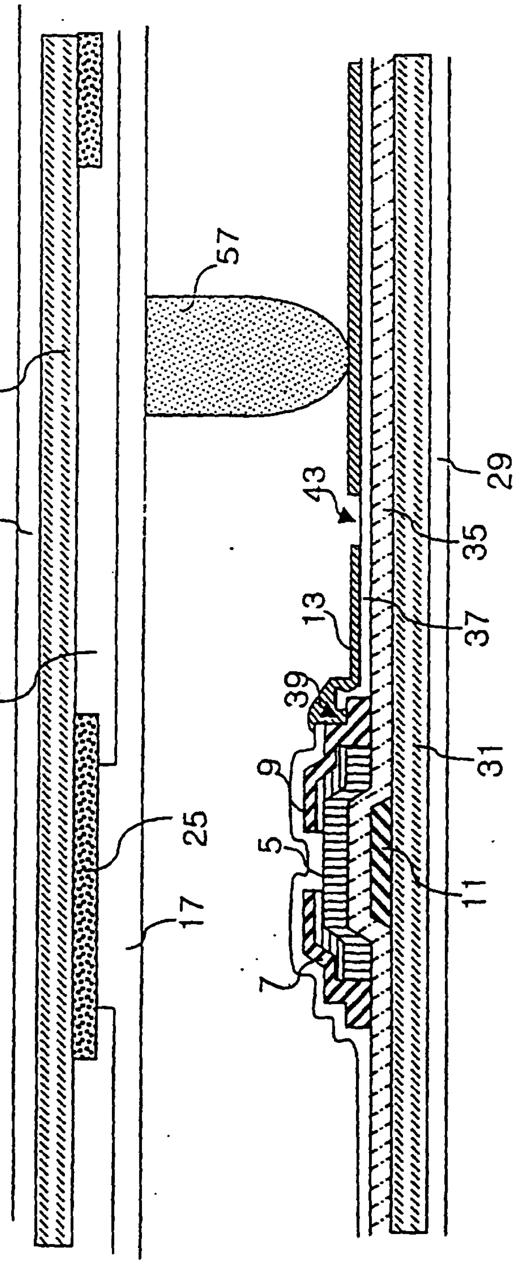
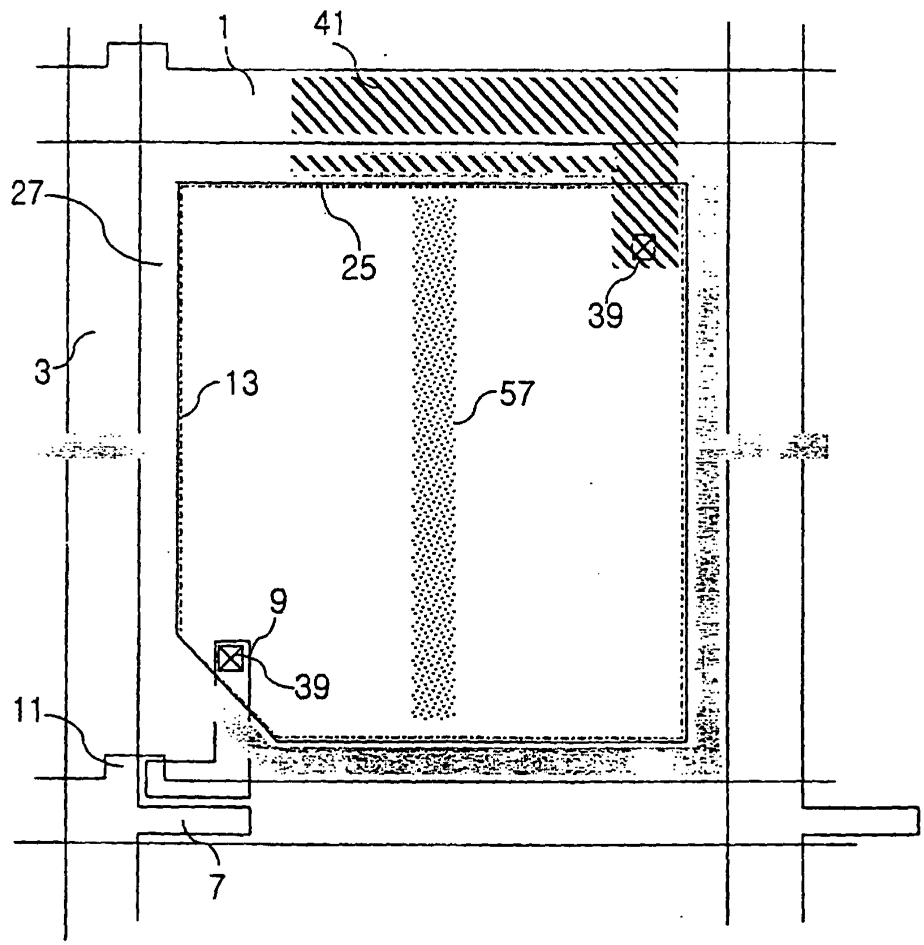


FIG. 17C

FIG. 18A



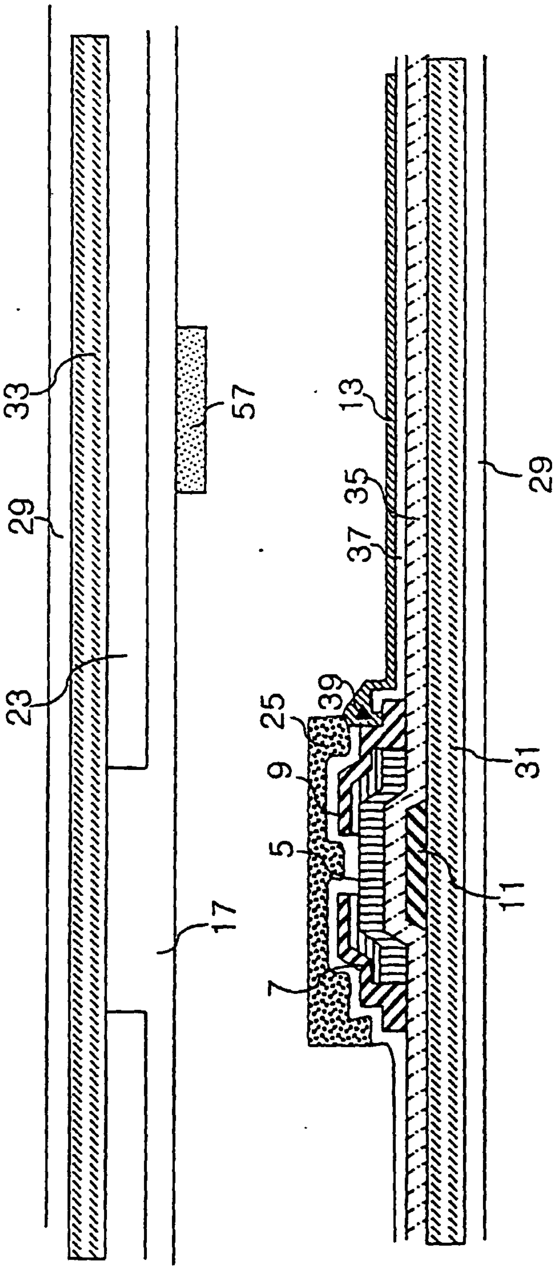


FIG. 18B

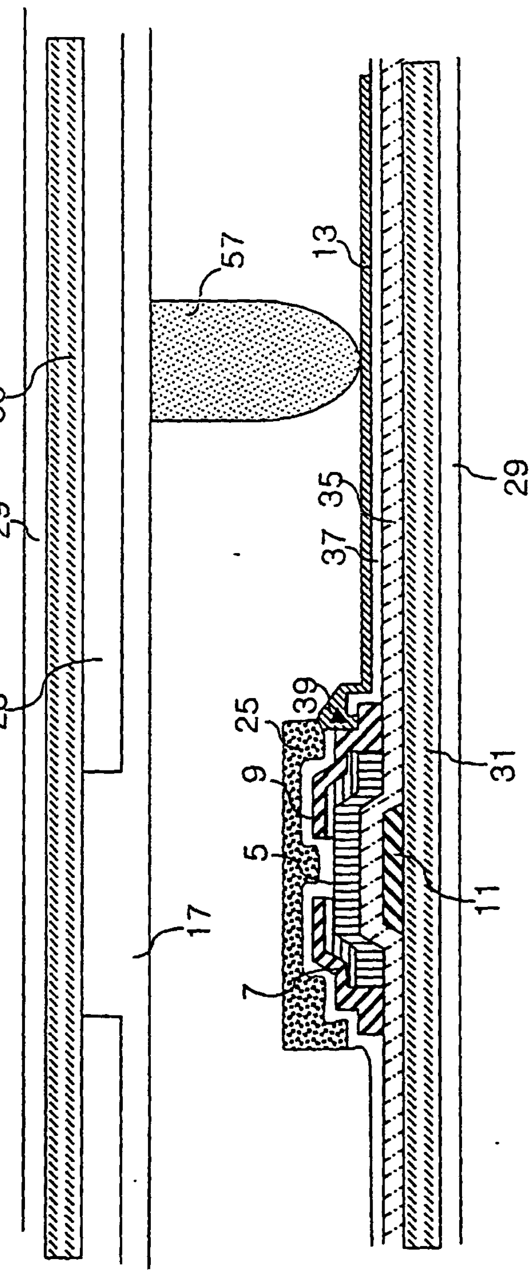


FIG. 18C

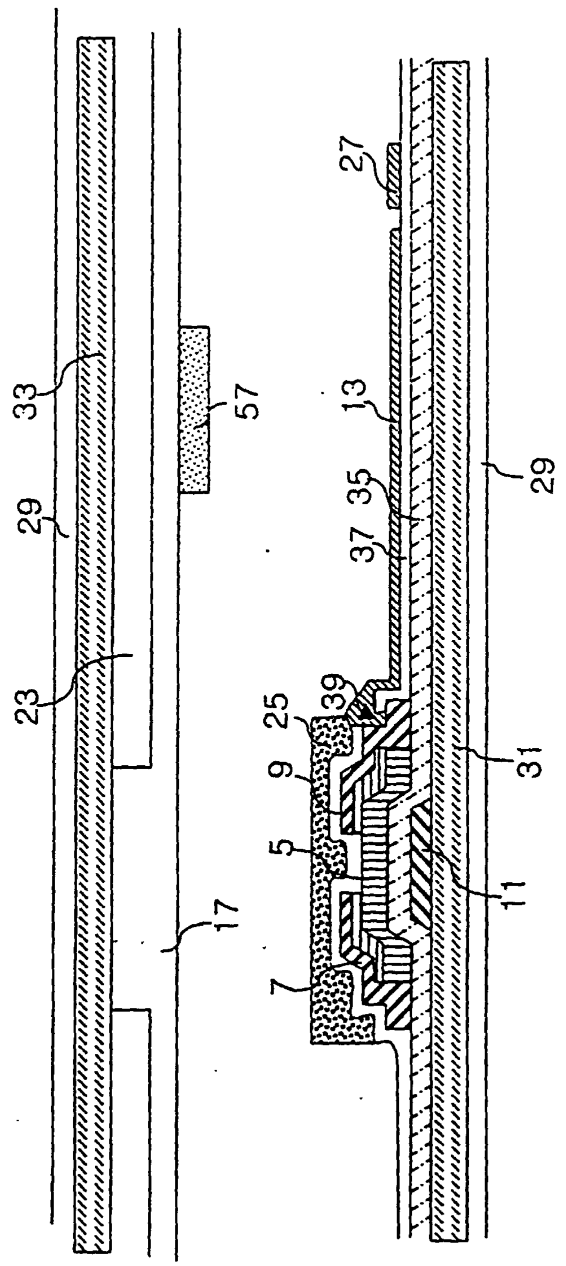


FIG. 18D

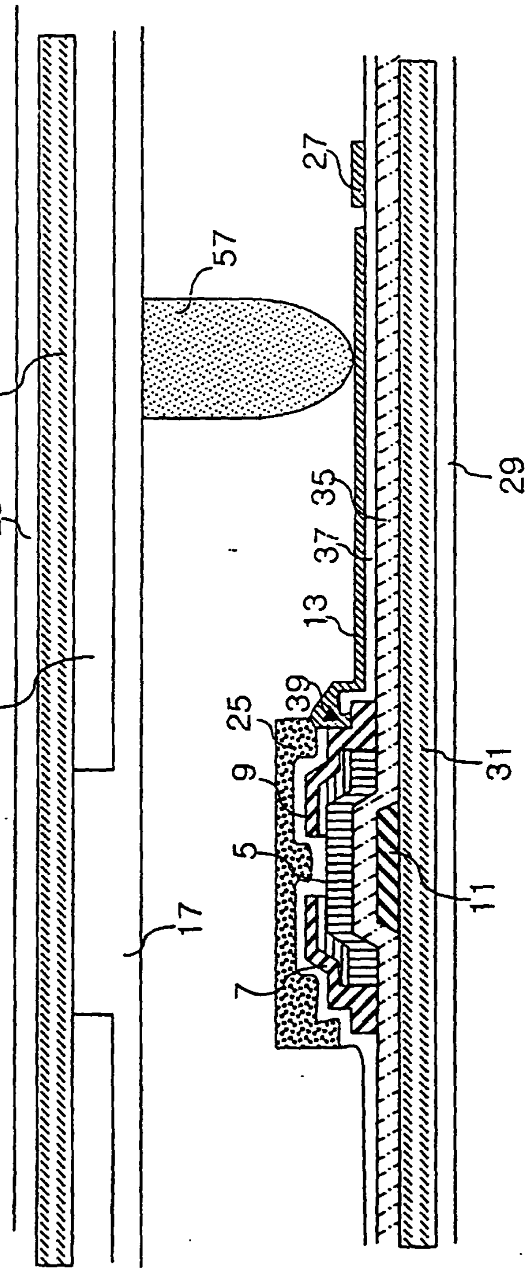


FIG. 18E

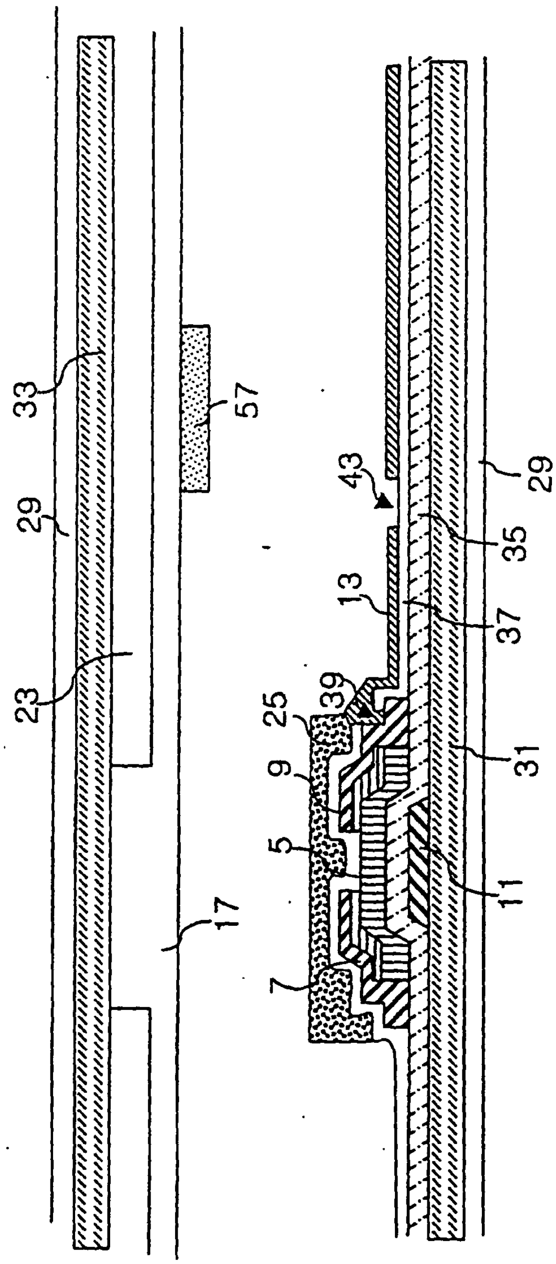


FIG. 18F

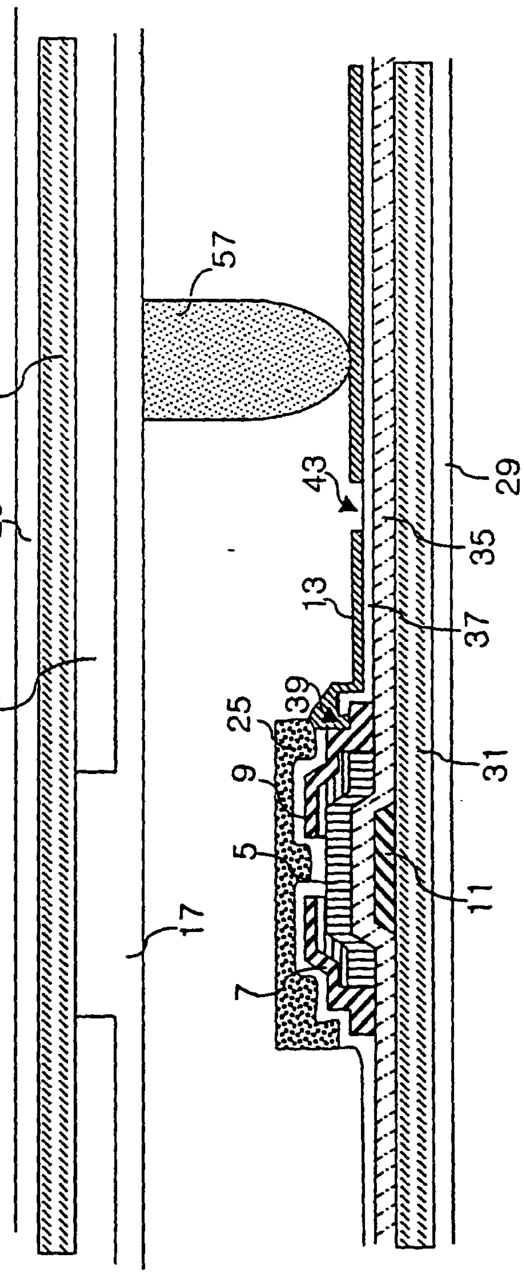


FIG. 18G

FIG. 19A

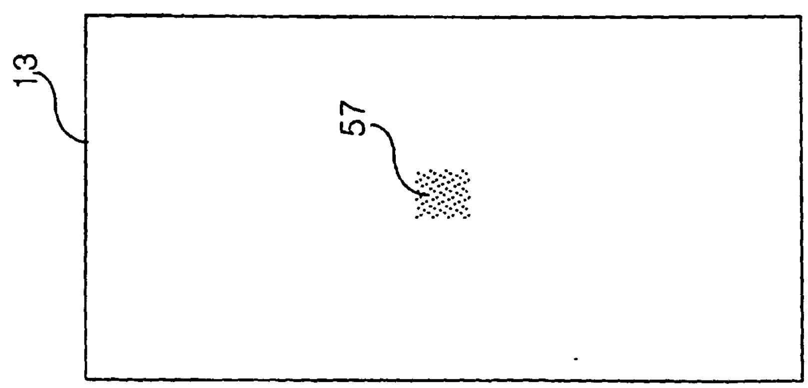


FIG. 19B

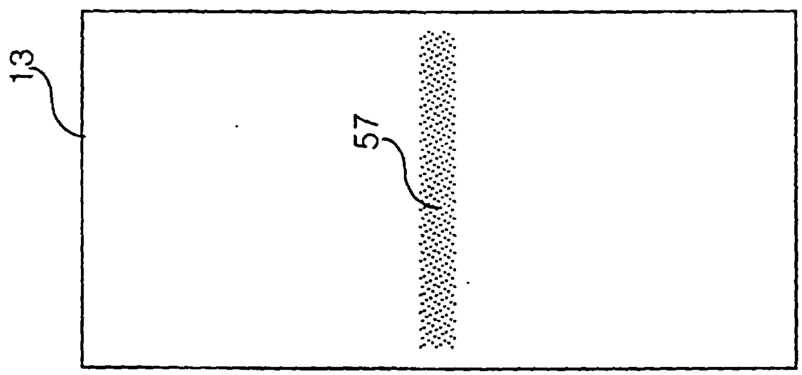
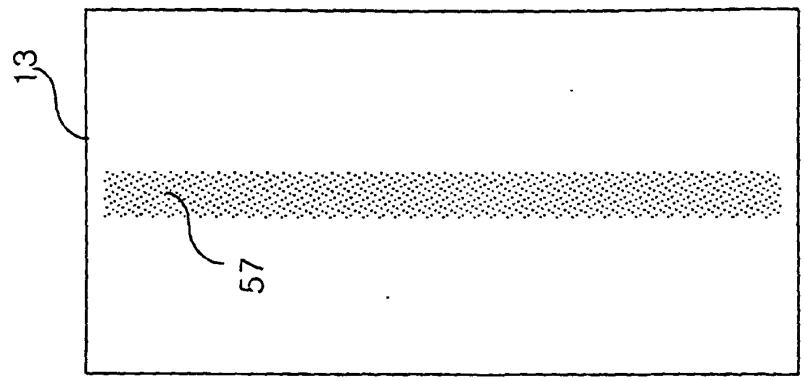


FIG. 19C



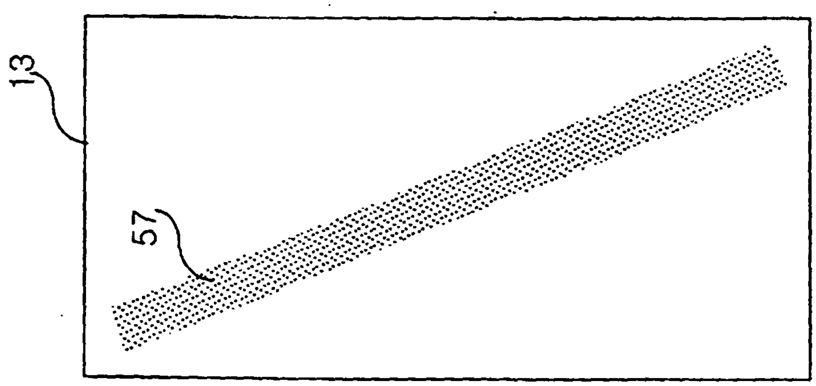


FIG. 19D

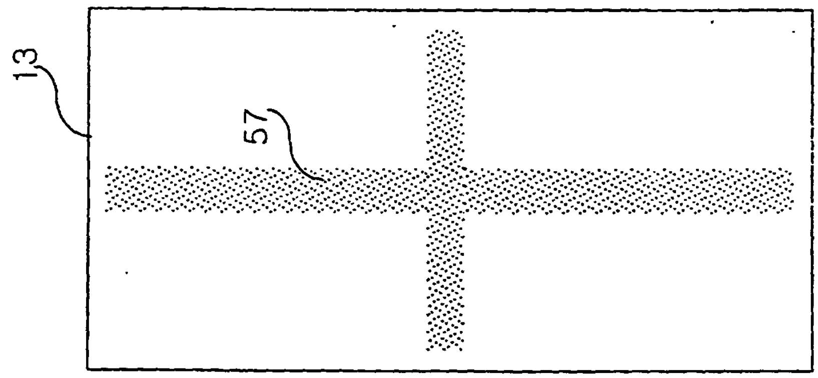


FIG. 19E

FIG. 19F

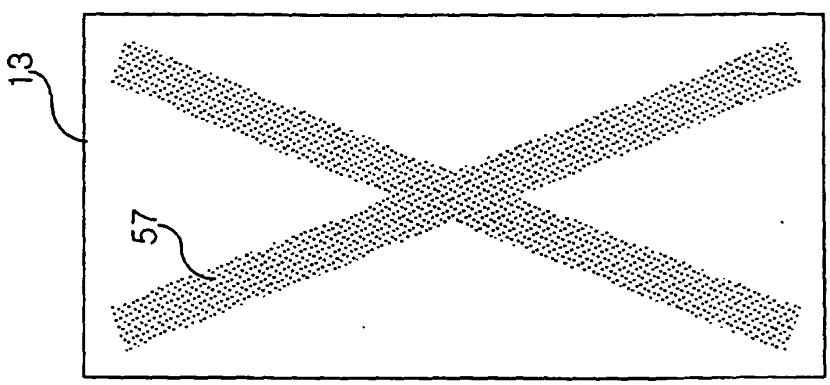
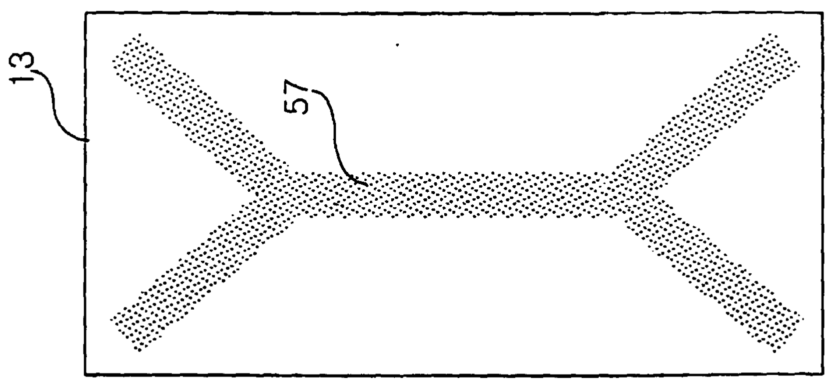


FIG. 19G



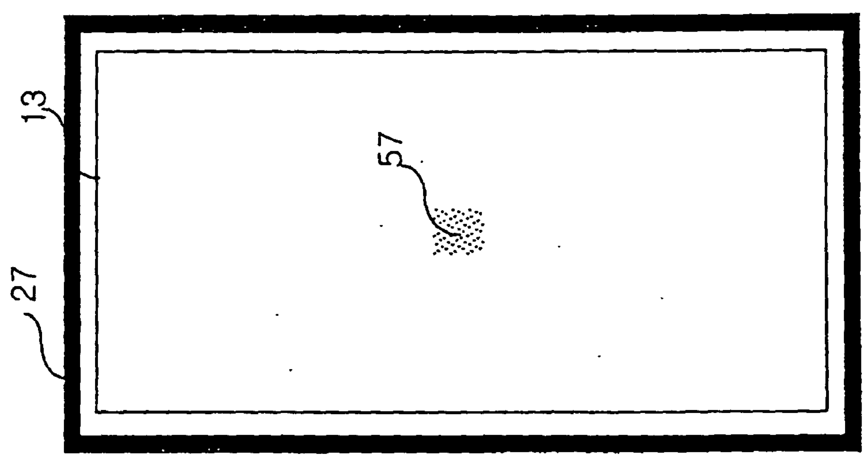


FIG. 20A

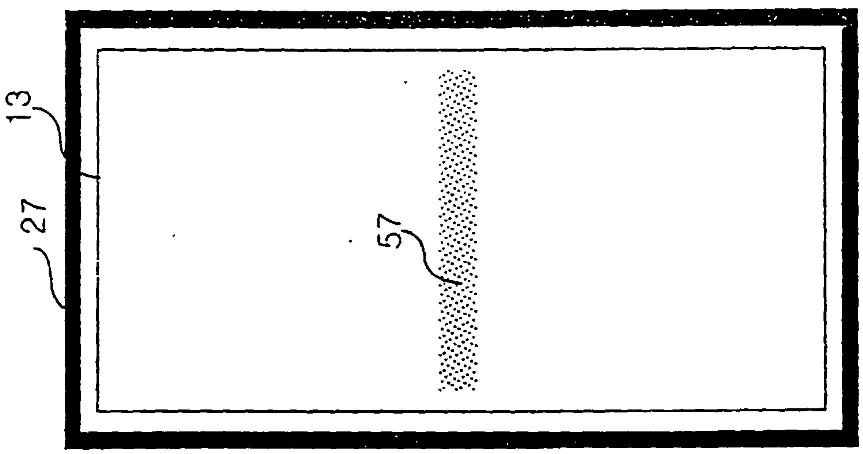


FIG. 20B

FIG. 20C

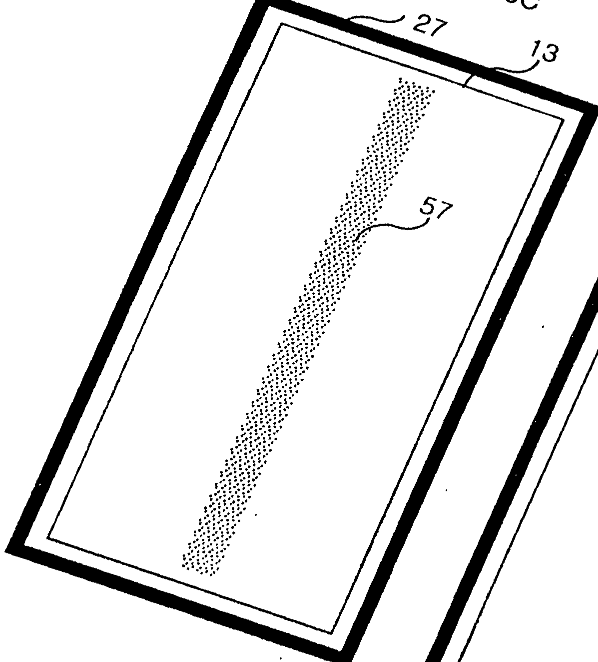
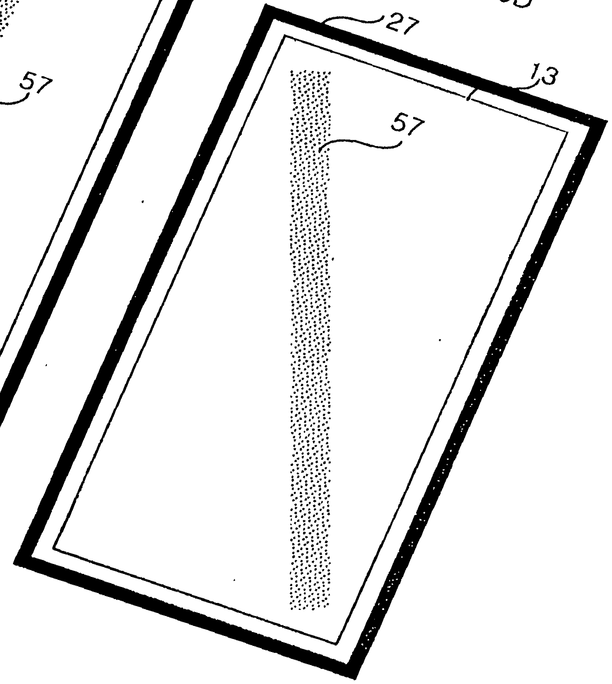


FIG. 20D



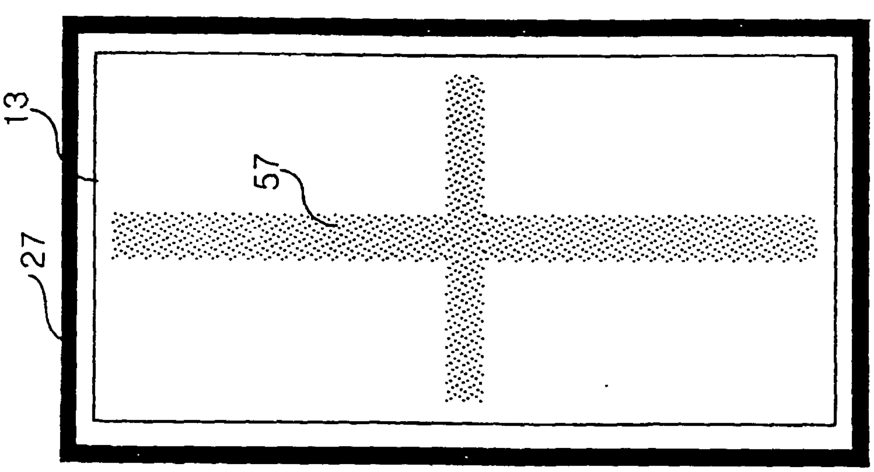


FIG. 20E

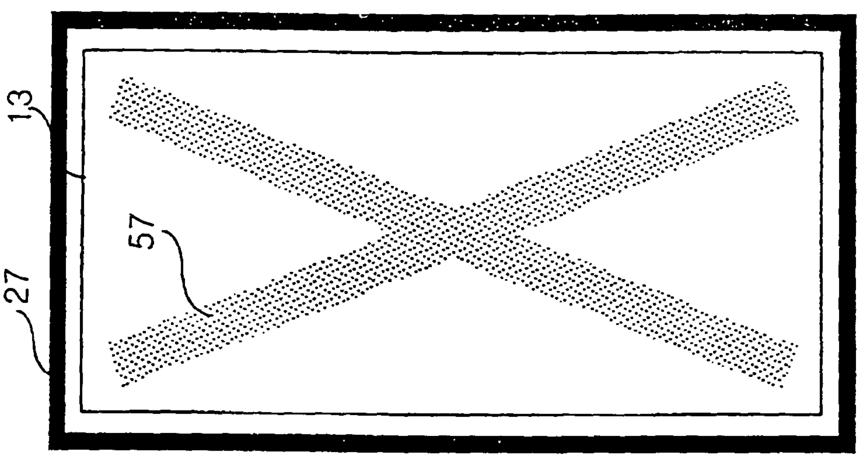


FIG. 20F

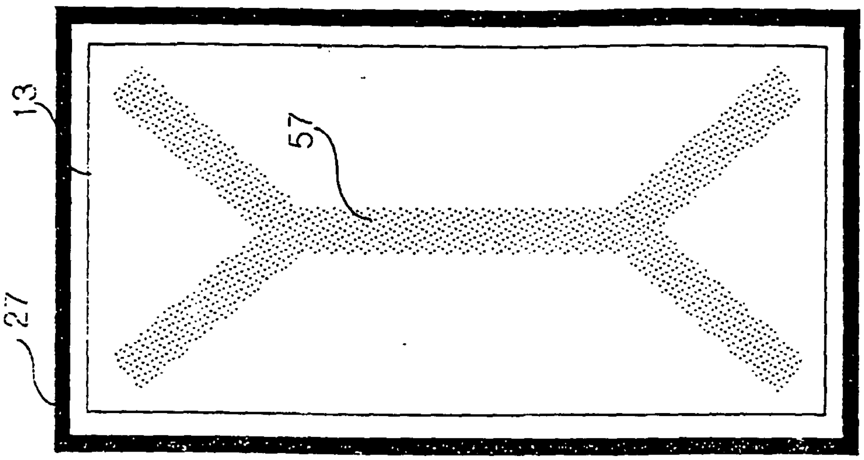


FIG. 20G

FIG. 21A

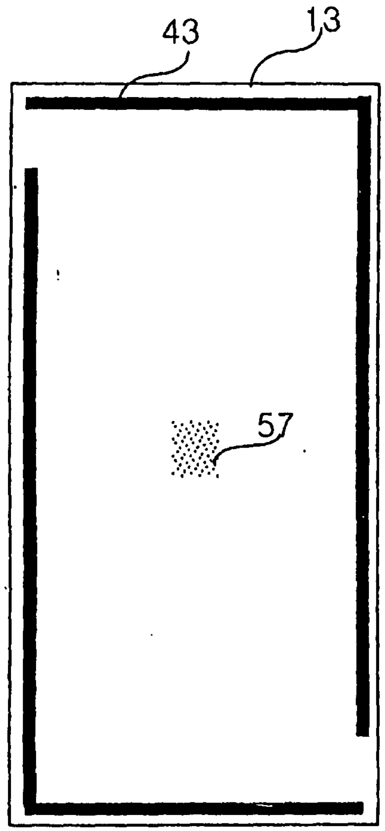


FIG. 21B

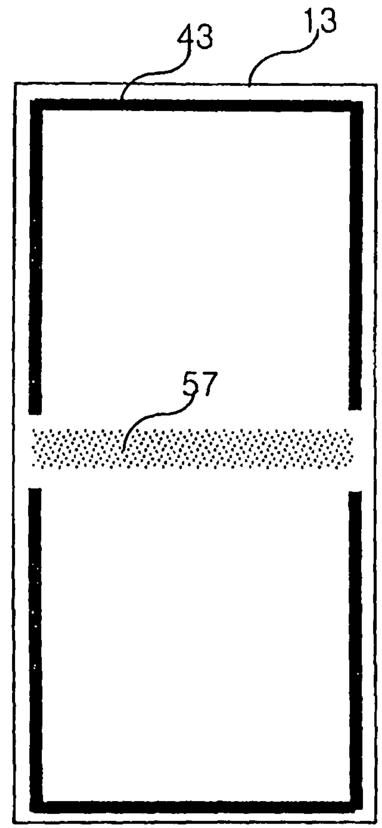
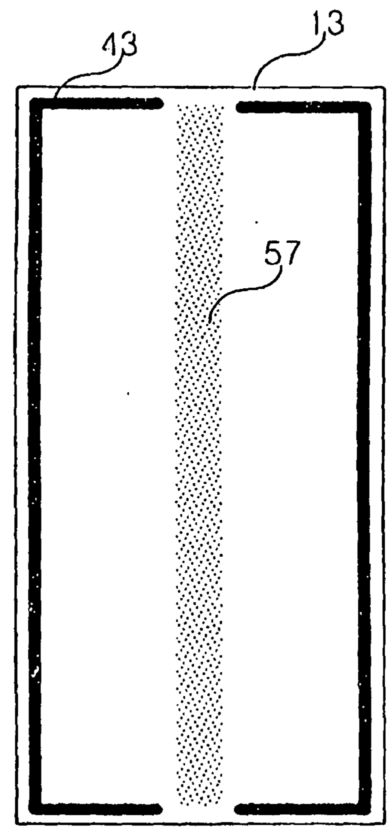


FIG. 21C



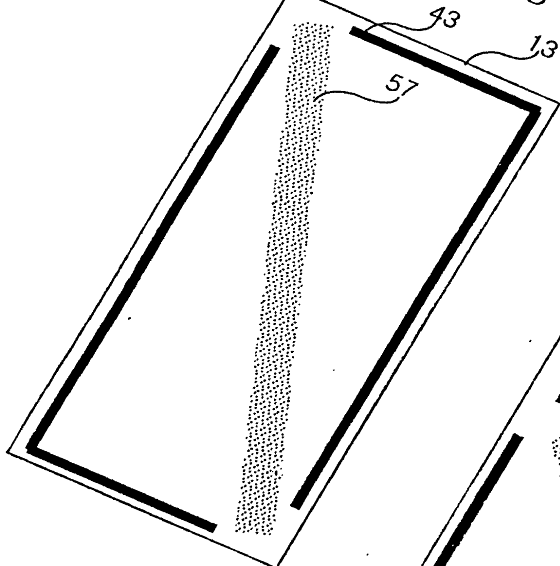


FIG. 21D

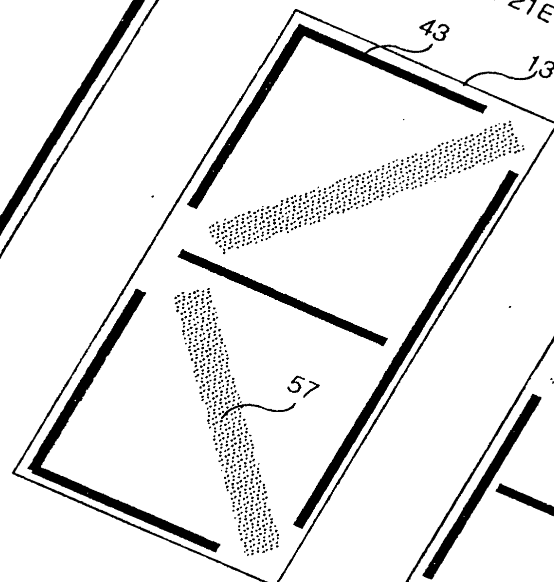


FIG. 21E

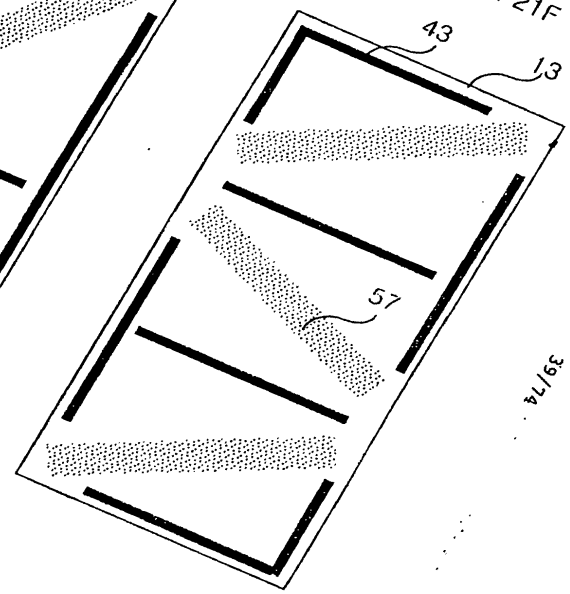


FIG. 21F

FIG. 21G

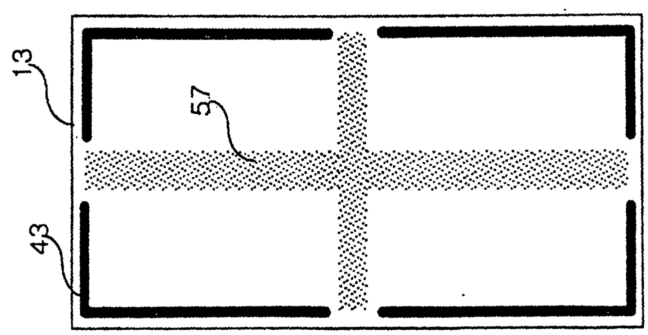


FIG. 21H

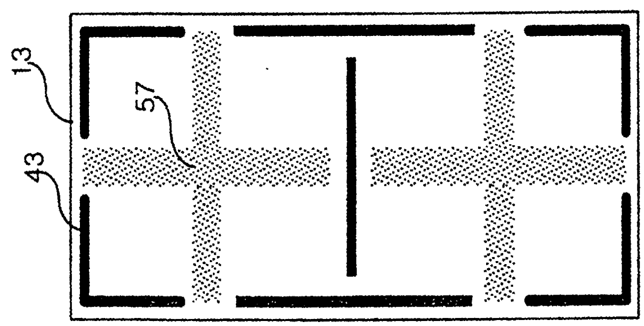
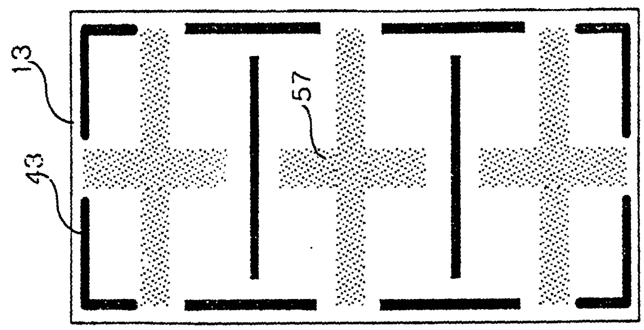


FIG. 21I



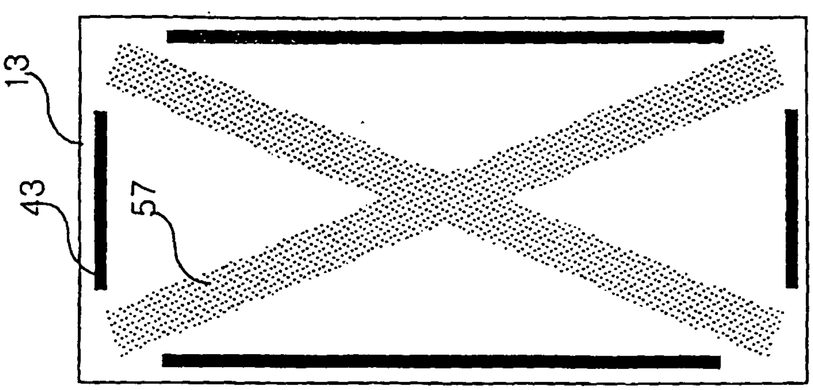


FIG. 21J

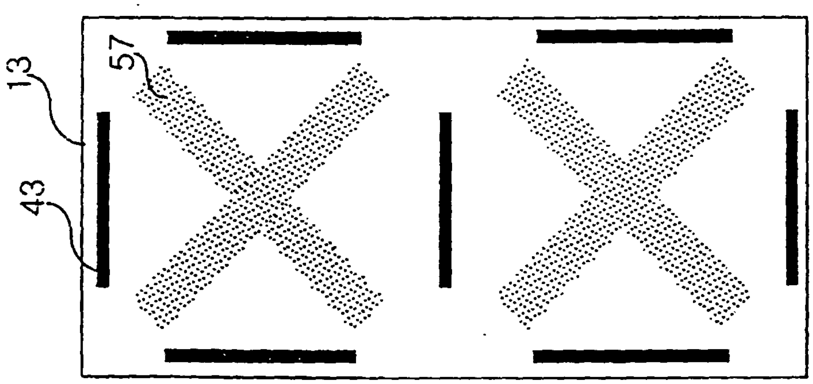


FIG. 21K

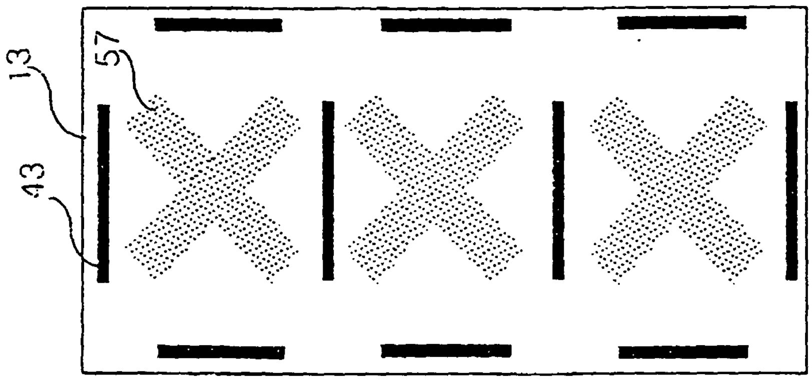


FIG. 21L

FIG. 21M

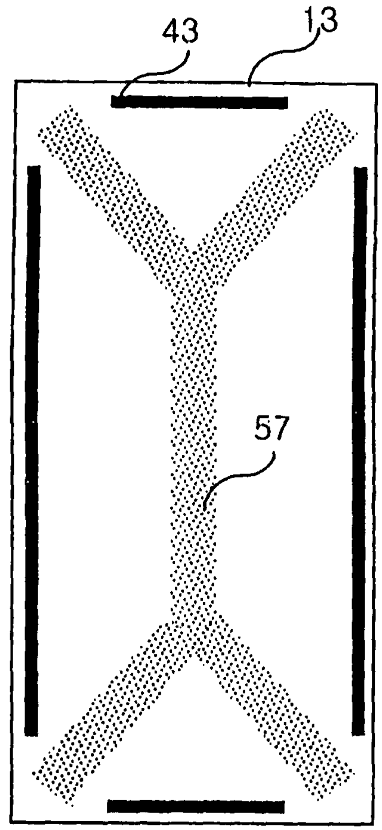


FIG. 22A

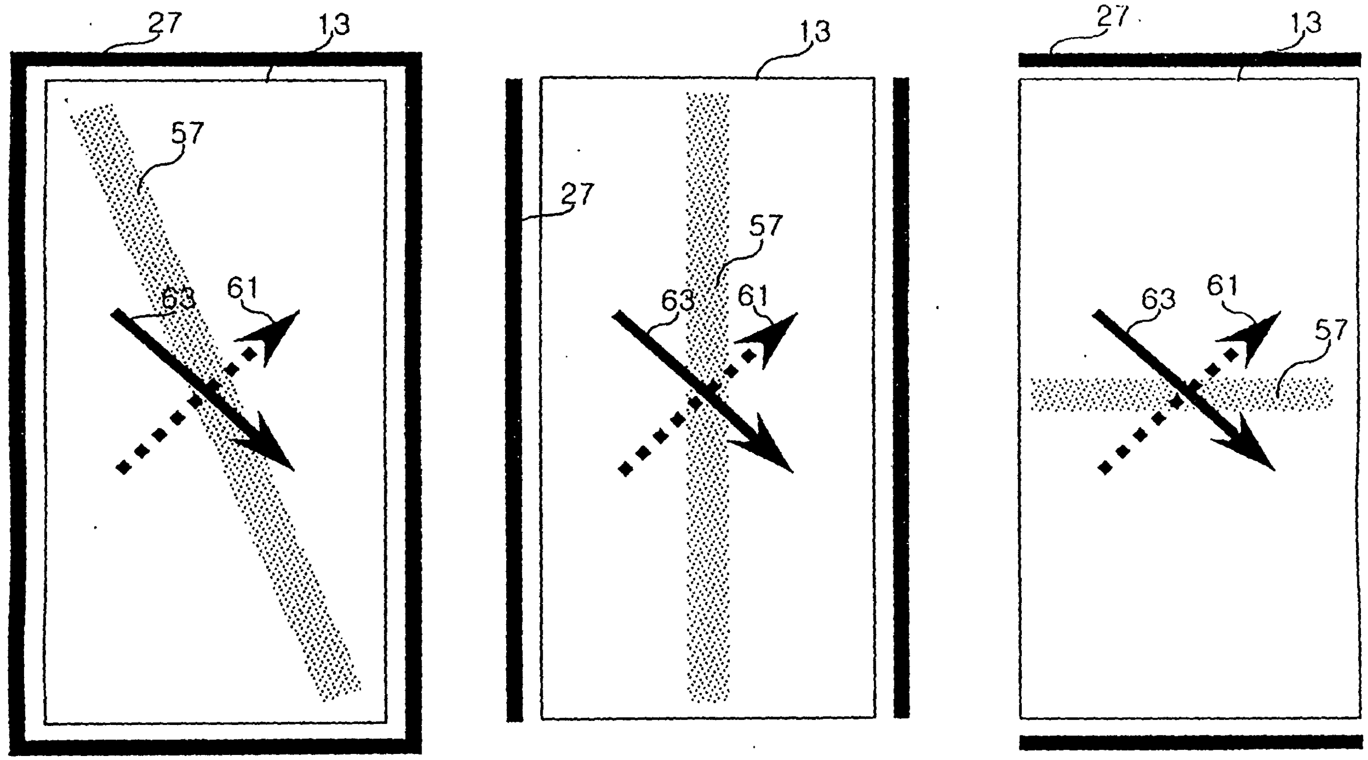


FIG. 22B

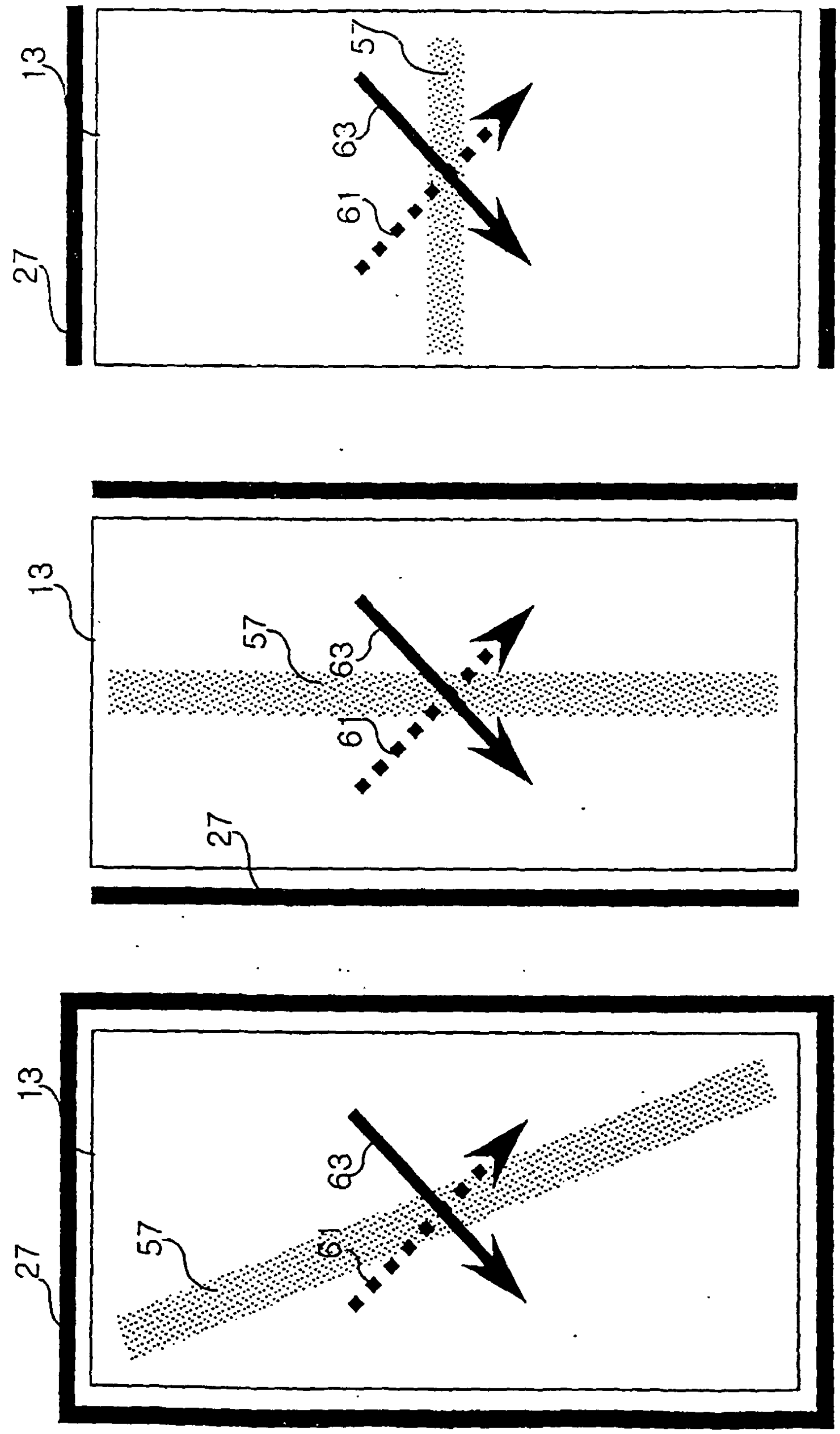


FIG. 22C

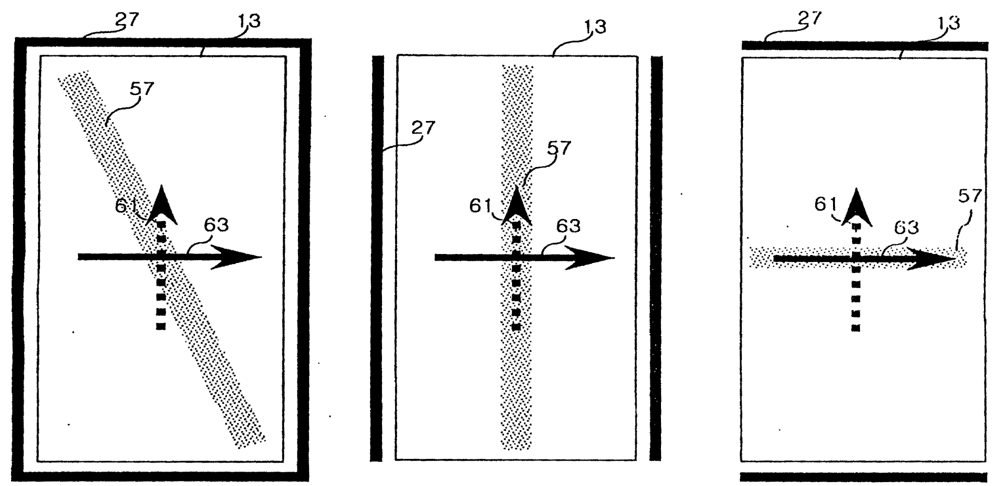


FIG. 22D

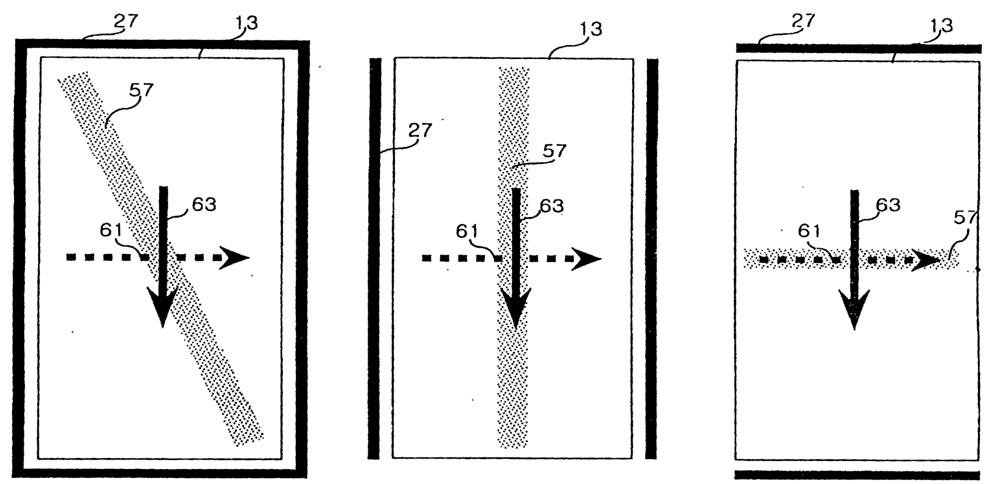


FIG. 23A

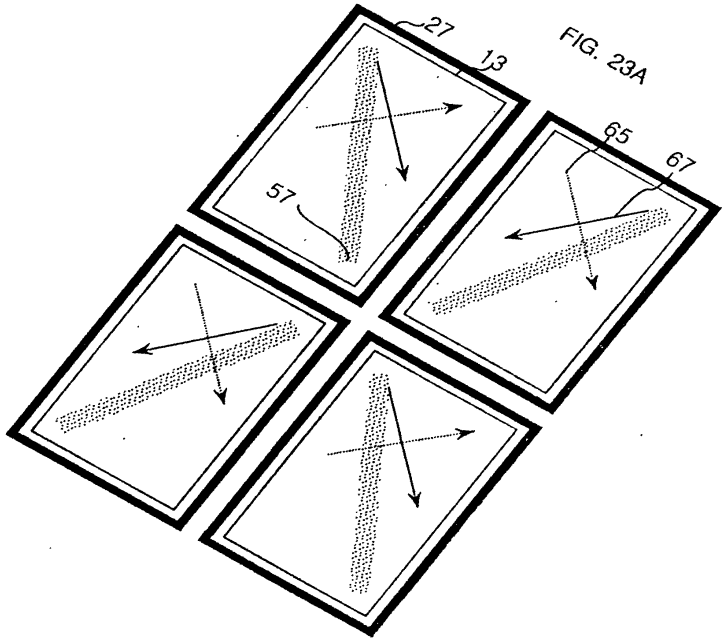


FIG. 23C

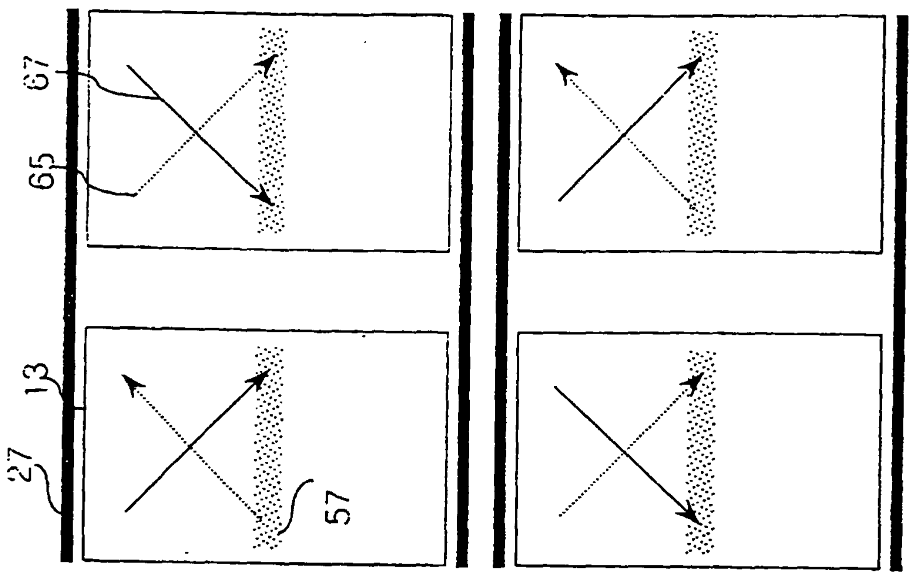
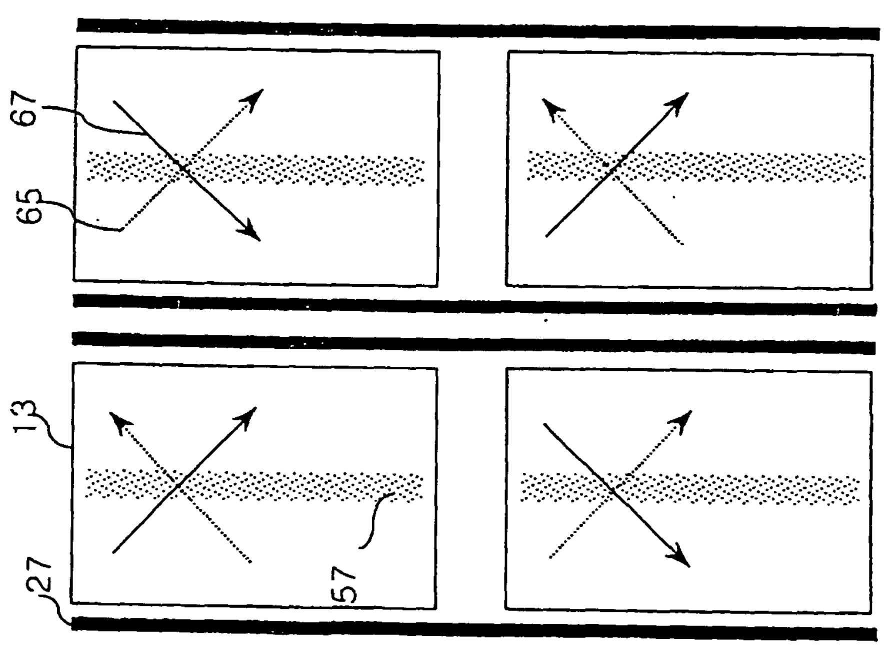


FIG. 23B



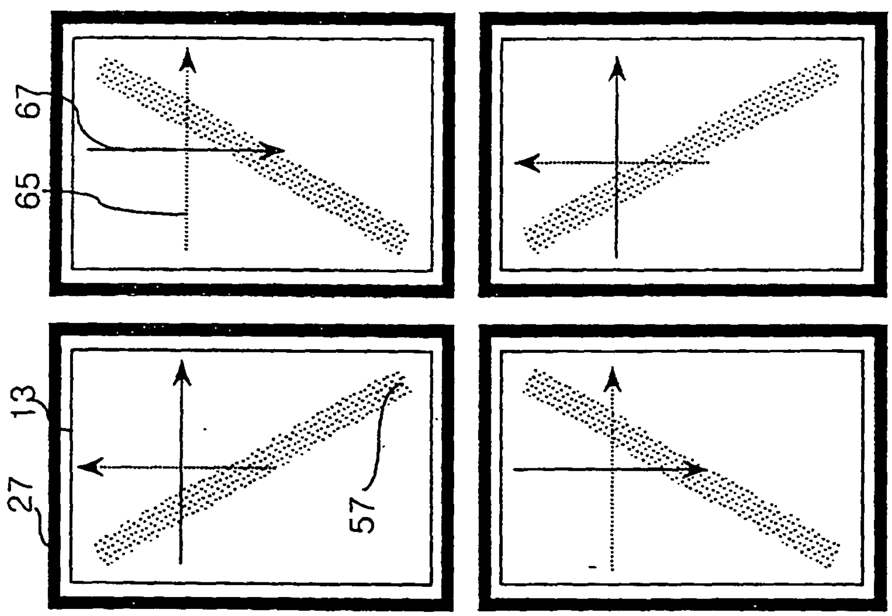


FIG. 24A

FIG. 24C

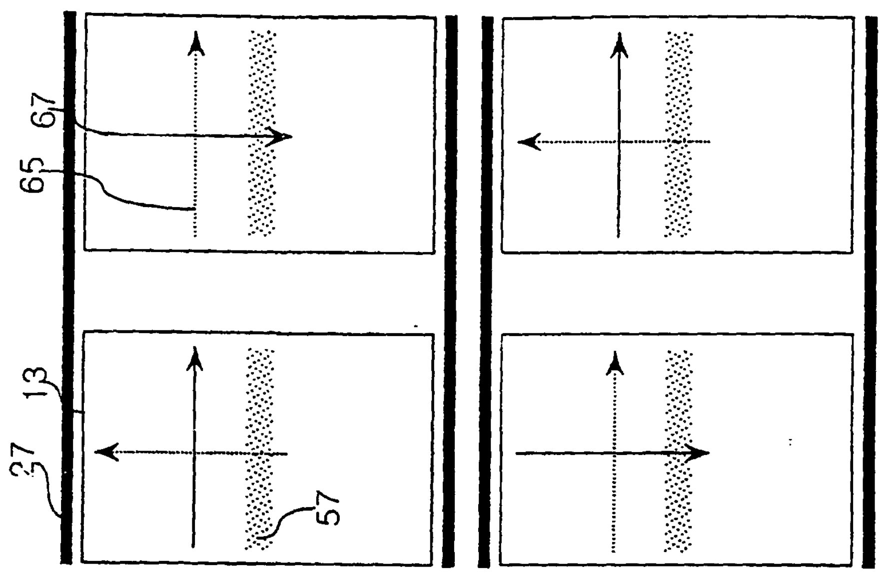
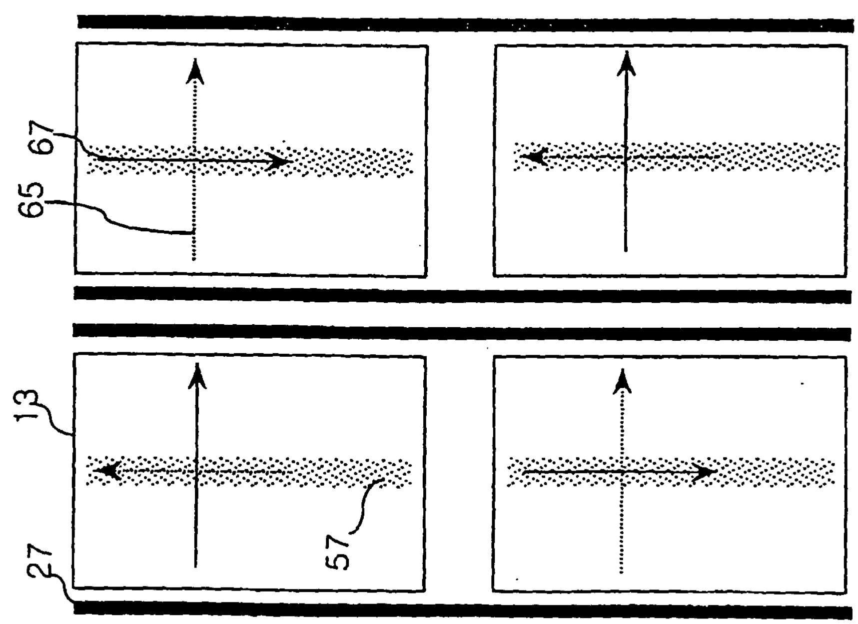


FIG. 24B



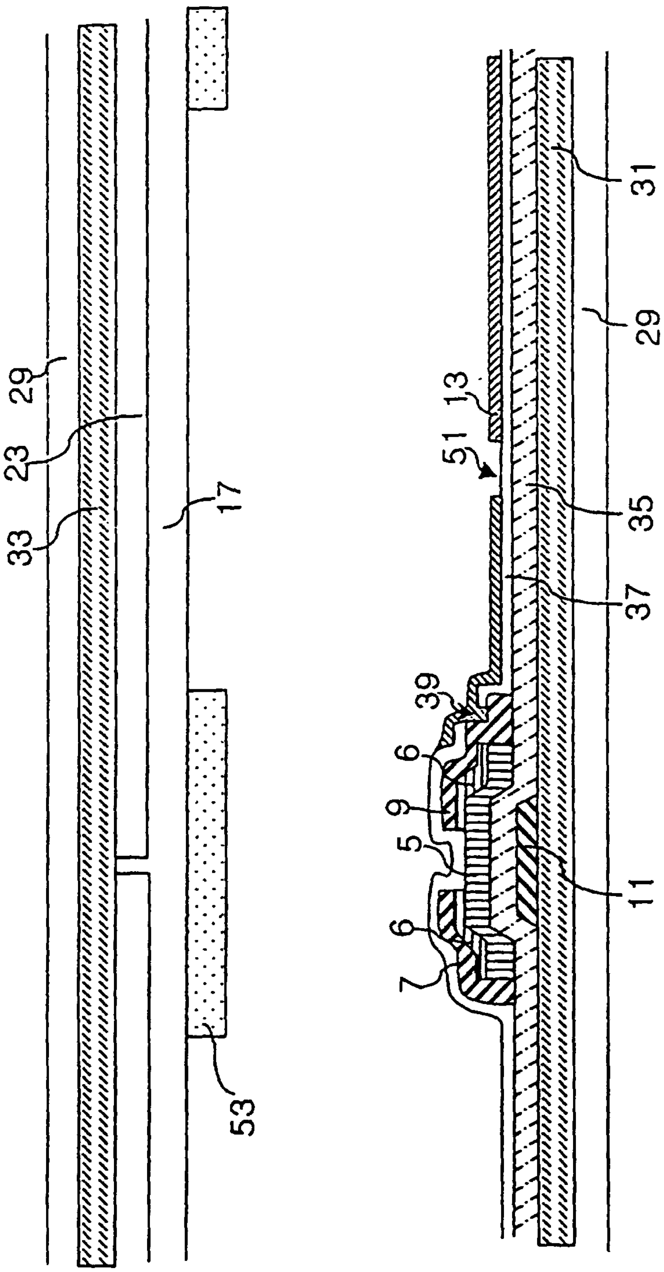


Fig. 25A

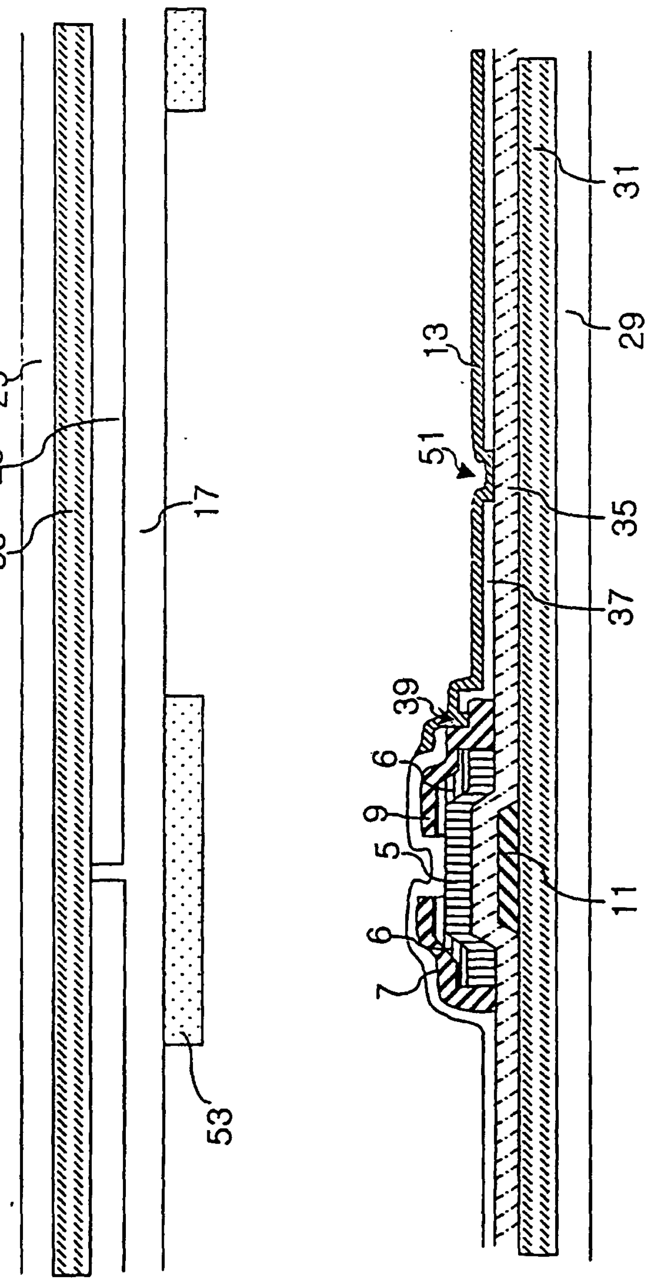


Fig. 25B

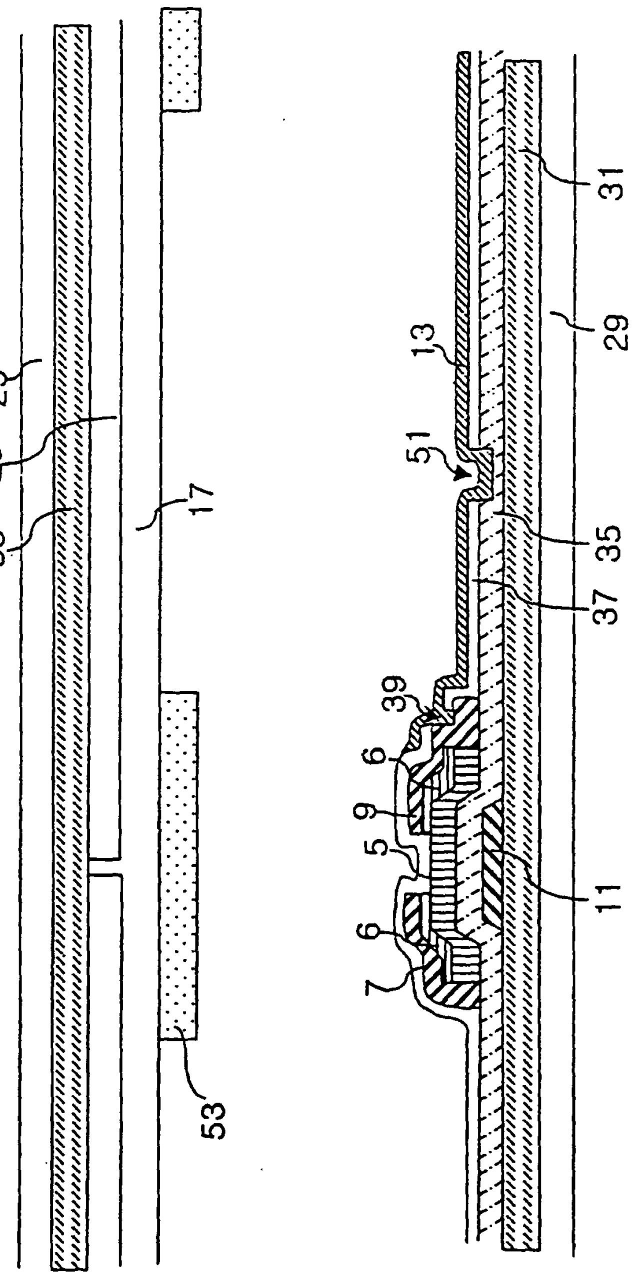


Fig. 25C

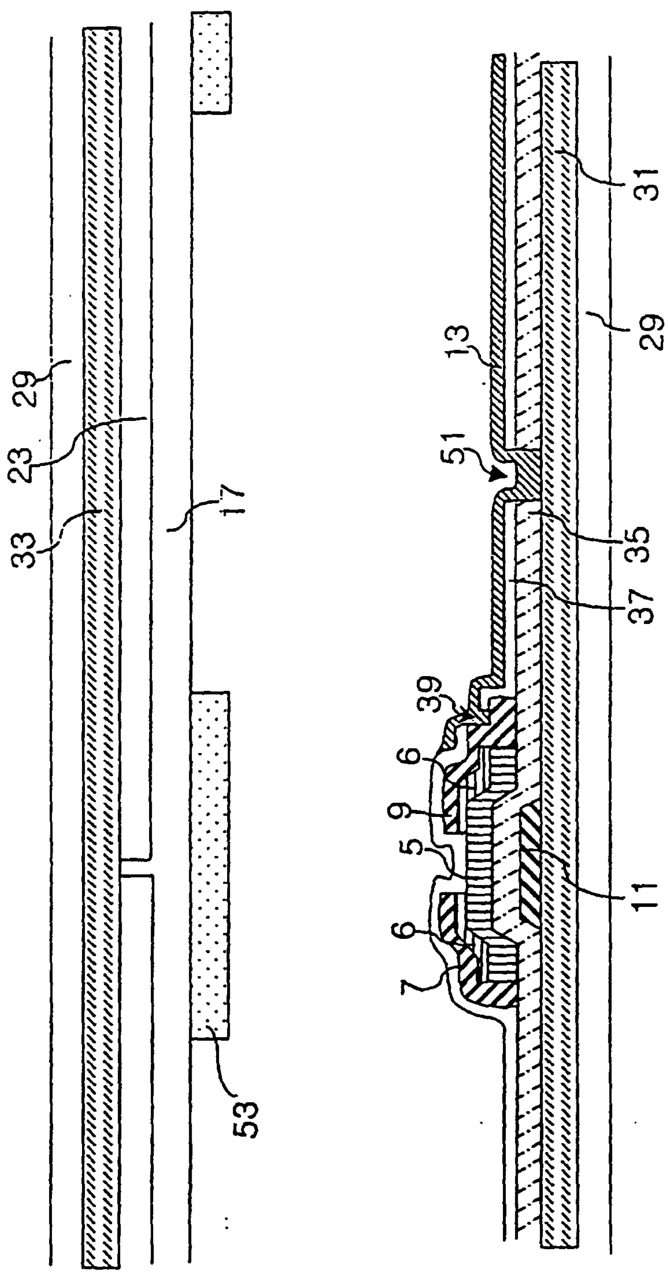


Fig. 25D

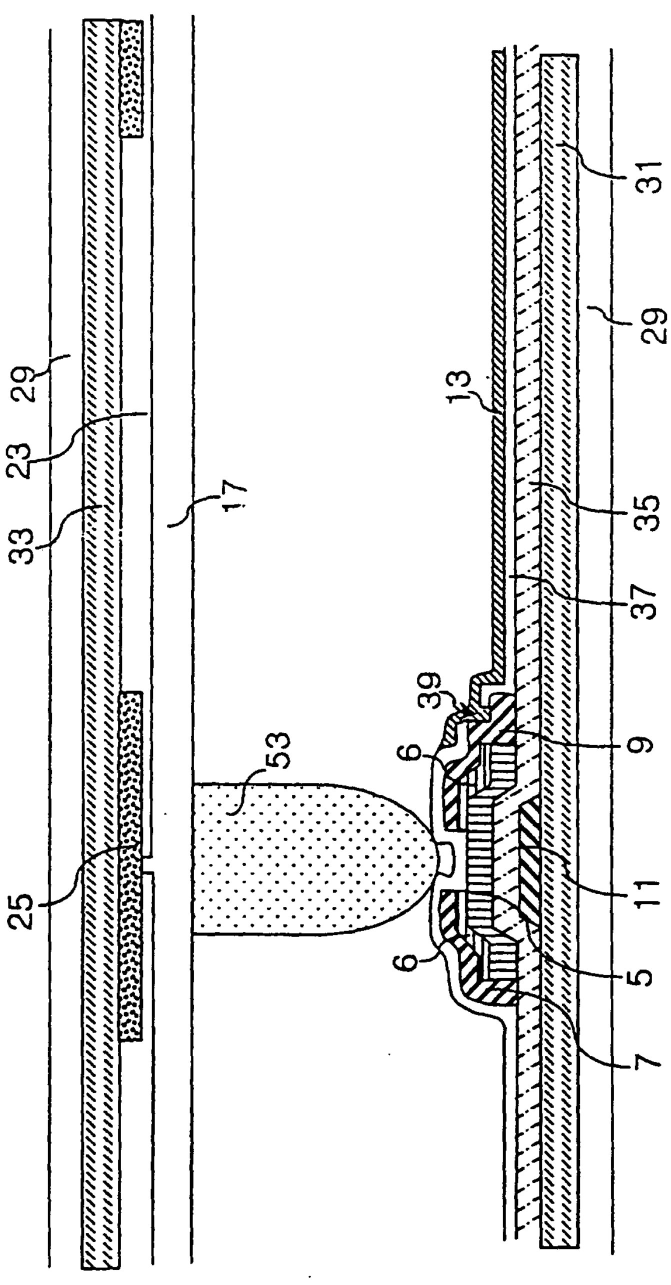


Fig. 26A

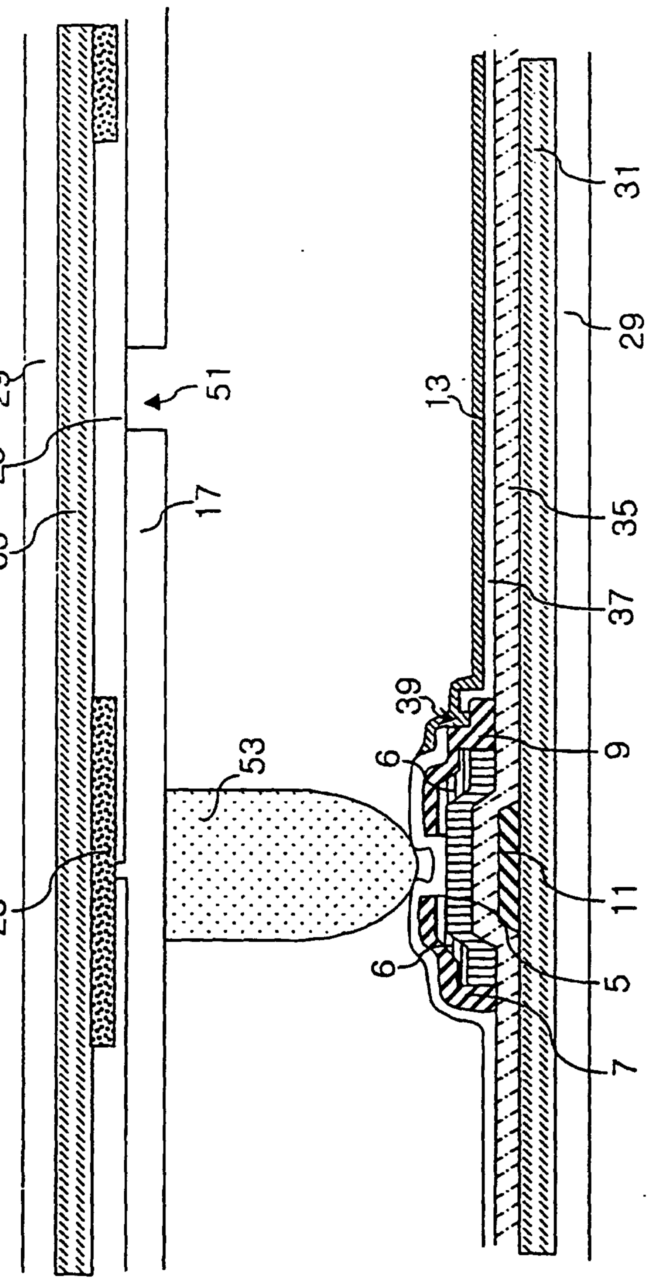


Fig. 26B

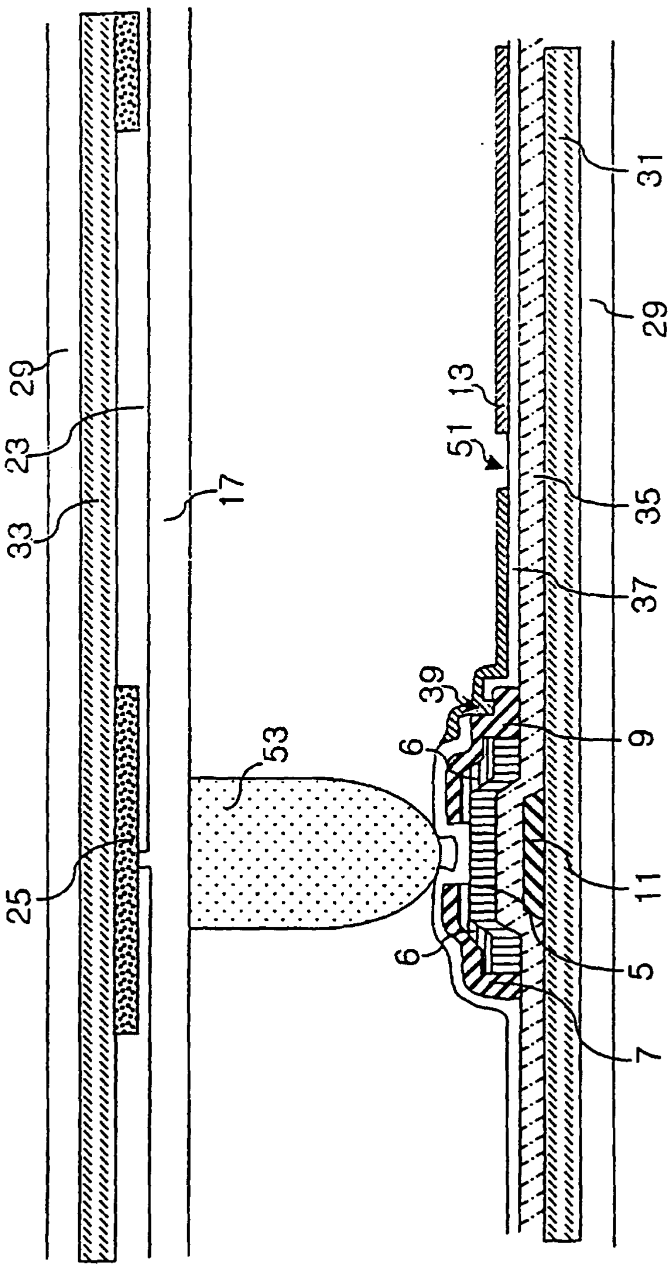


Fig. 26C

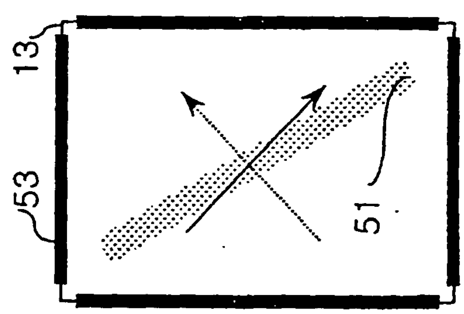


FIG. 27A

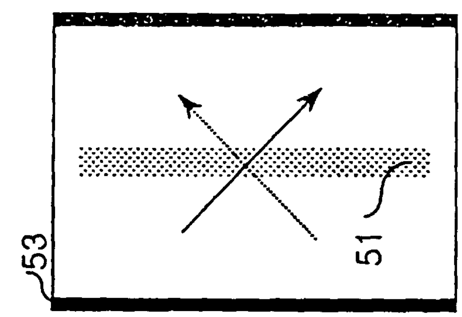


FIG. 27B

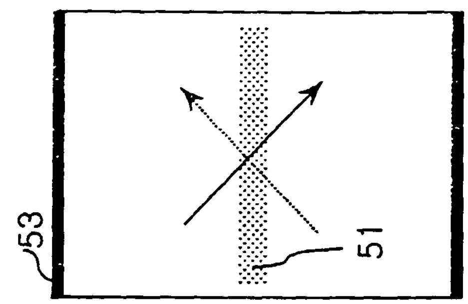


FIG. 27C

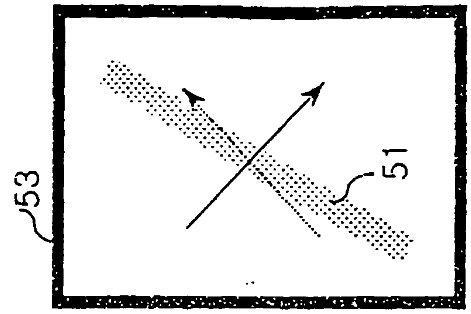


FIG. 27D

FIG. 28A

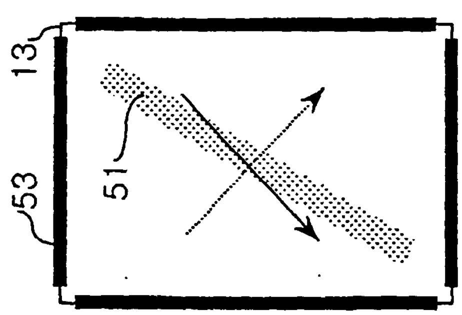


FIG. 28B

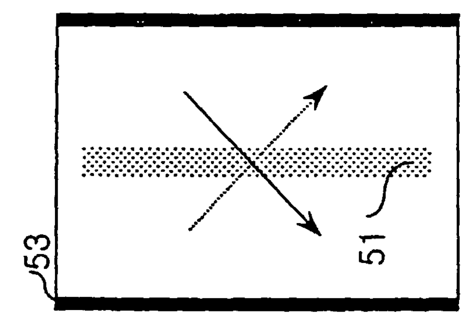


FIG. 28C

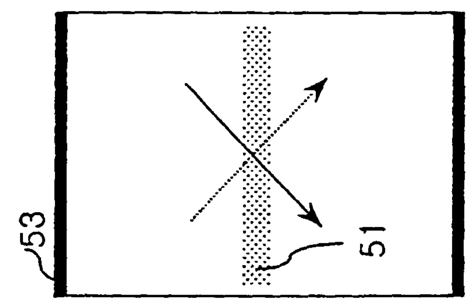


FIG. 28D

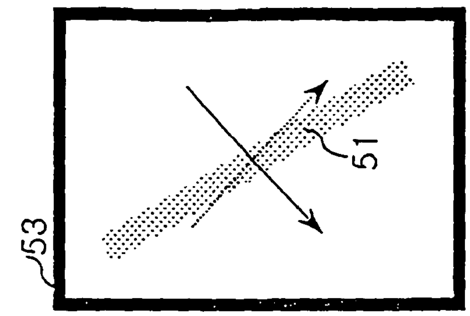


FIG. 29A

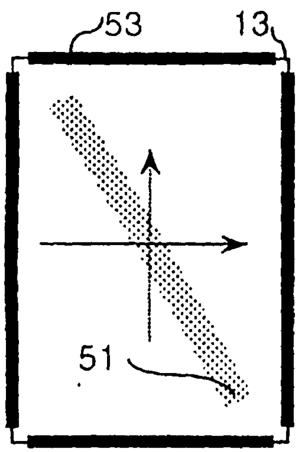


FIG. 29B

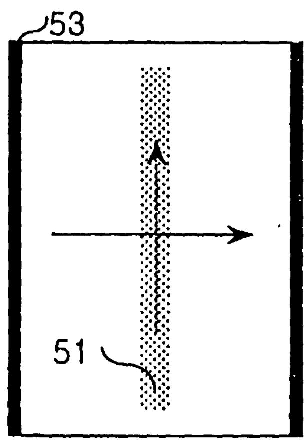


FIG. 29C

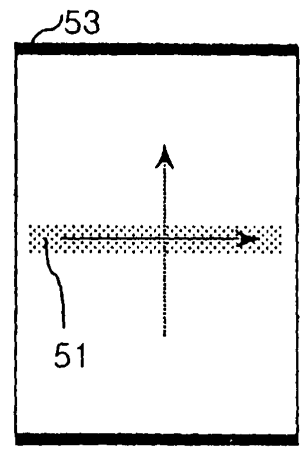
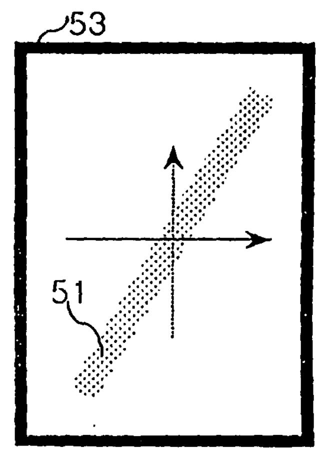


FIG. 29D



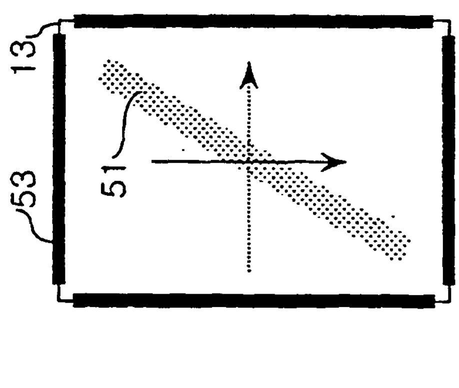


FIG. 30A

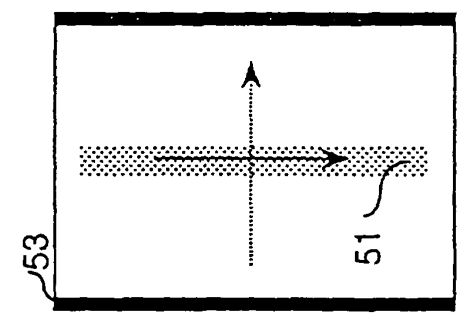


FIG. 30B

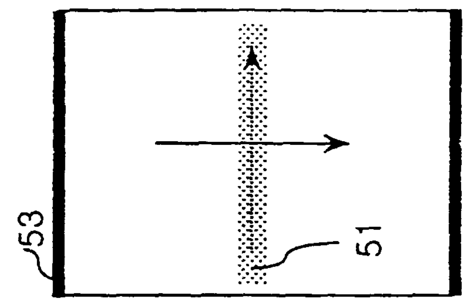


FIG. 30C

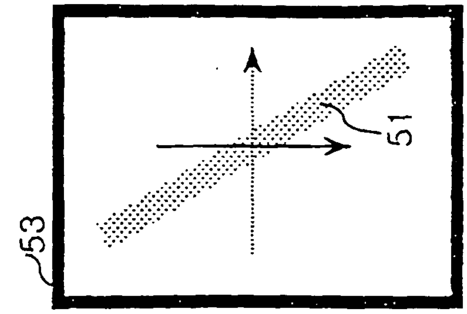


FIG. 30D

FIG. 31A

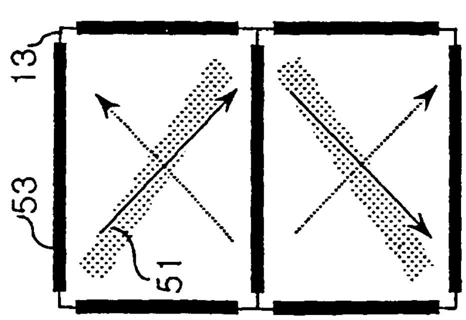


FIG. 31B

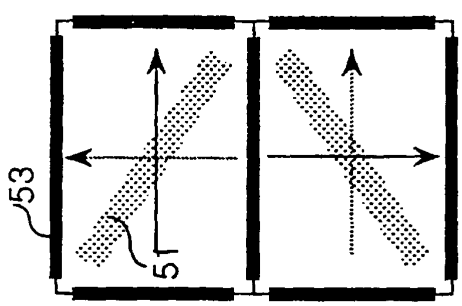


FIG. 31C

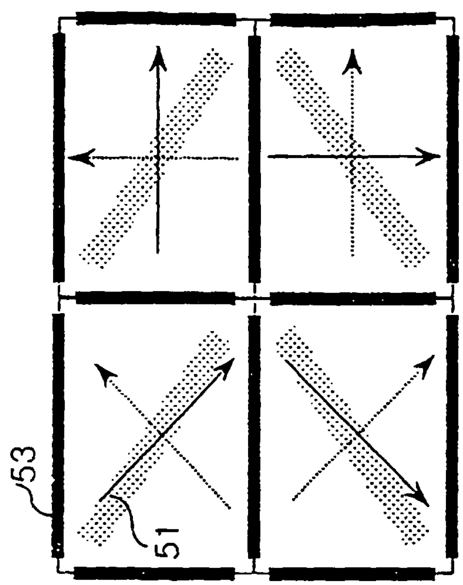


FIG. 31D

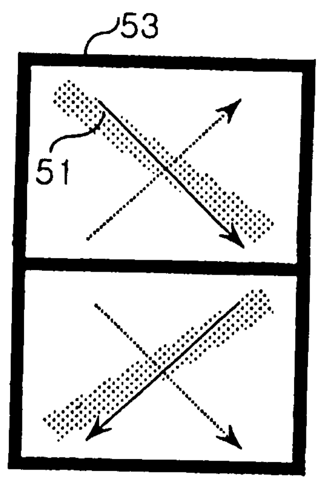


FIG. 31E

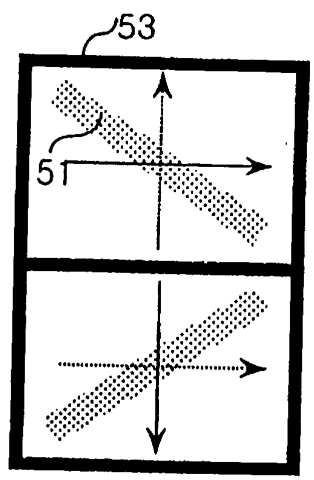


FIG. 31F

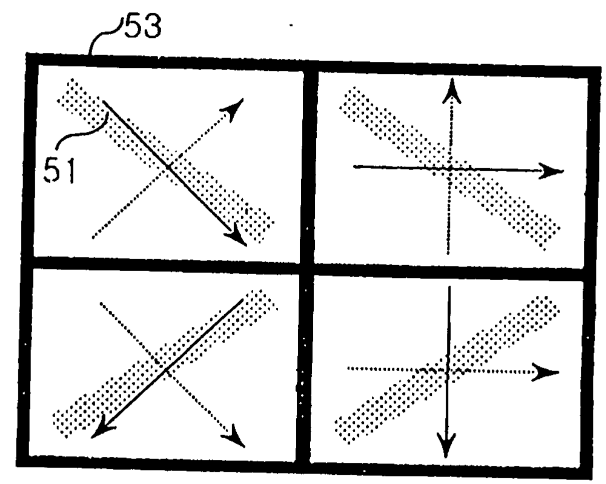


FIG. 32A

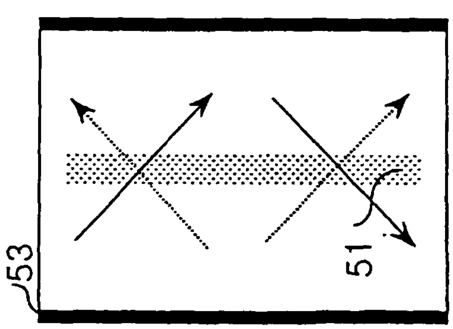


FIG. 32B

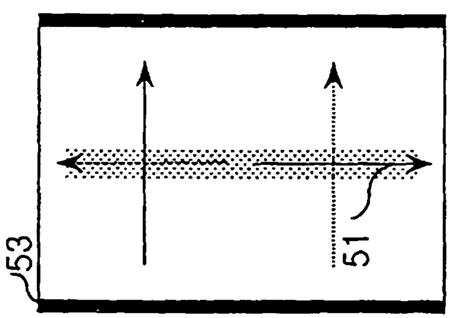
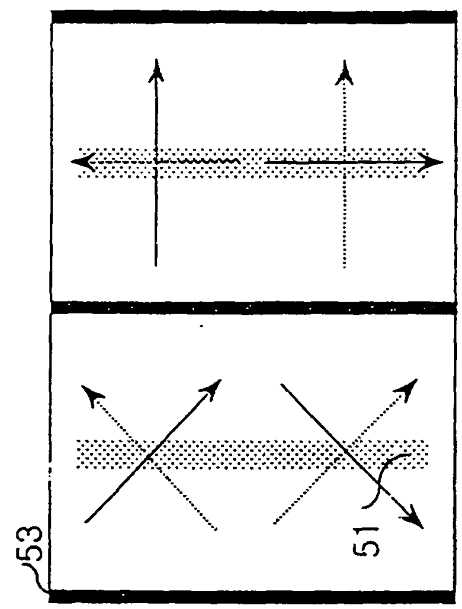


FIG. 32C



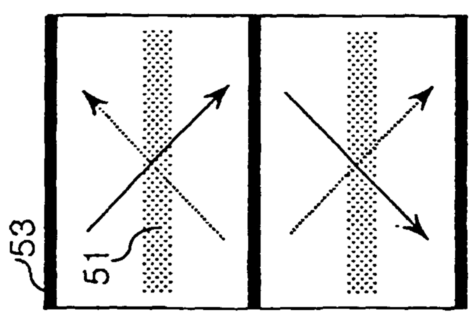


FIG. 33A

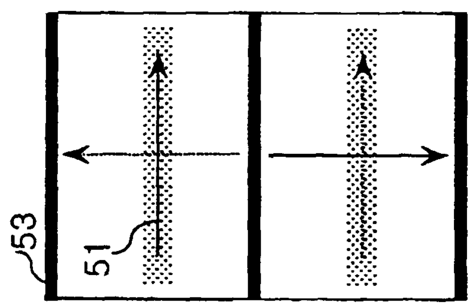


FIG. 33B

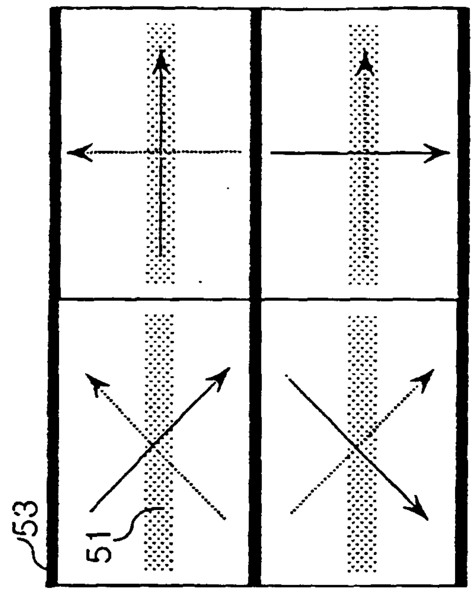


FIG. 33C

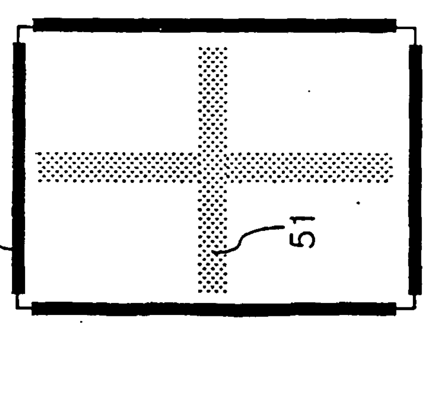


FIG. 34A

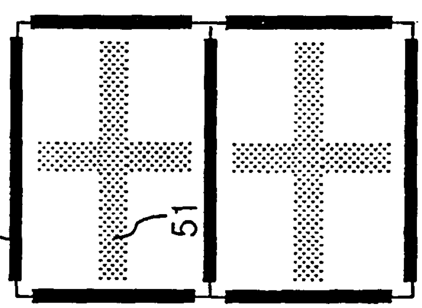


FIG. 34B

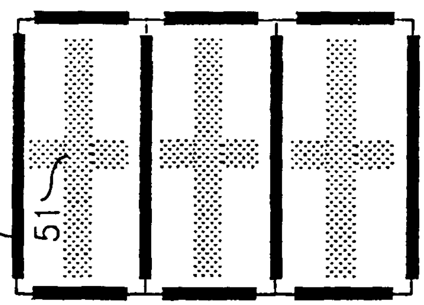


FIG. 34C

FIG. 34D

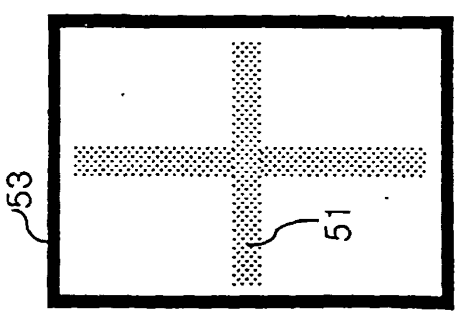


FIG. 34E

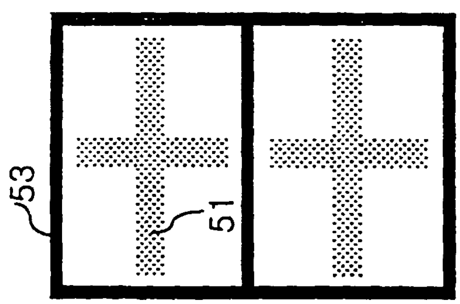
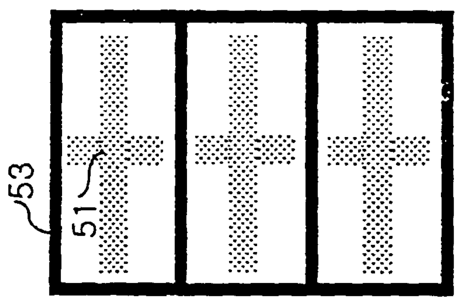


FIG. 34F



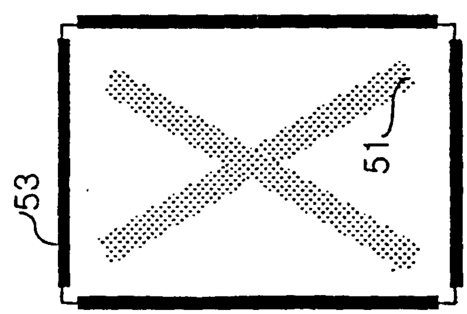


FIG. 35A

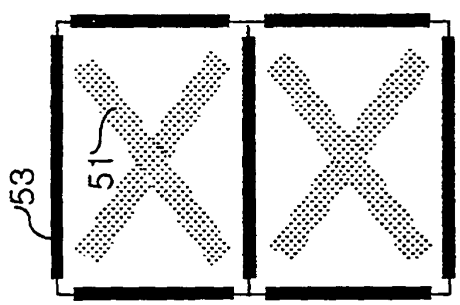


FIG. 35B

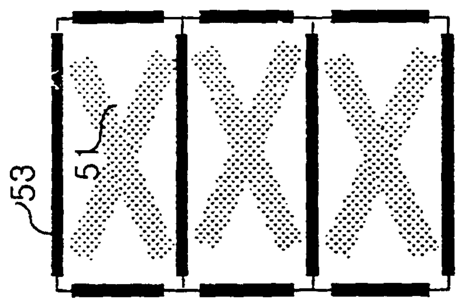


FIG. 35C

FIG. 35D

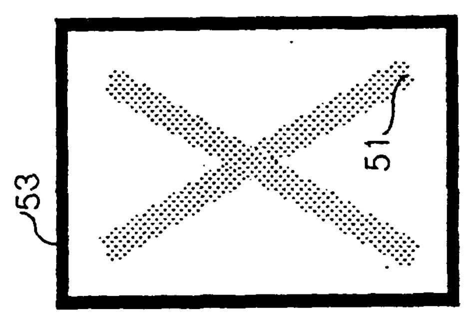


FIG. 35E

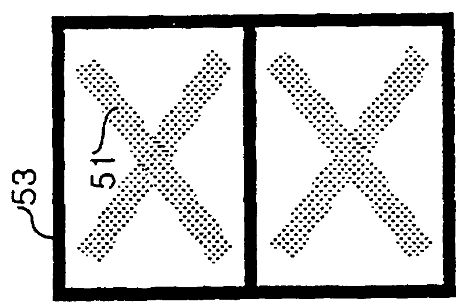


FIG. 35F

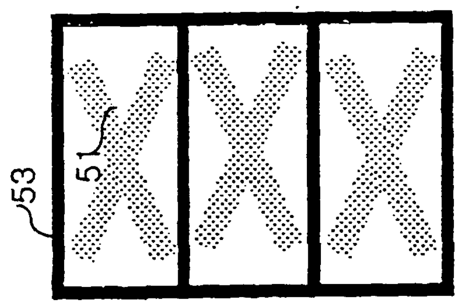


FIG. 36A

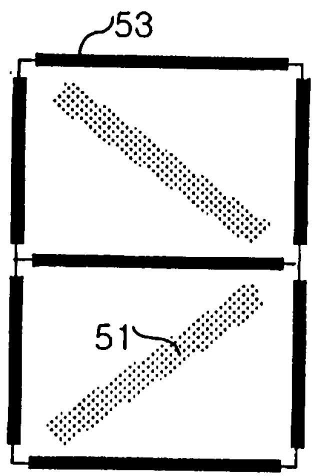


FIG. 36B

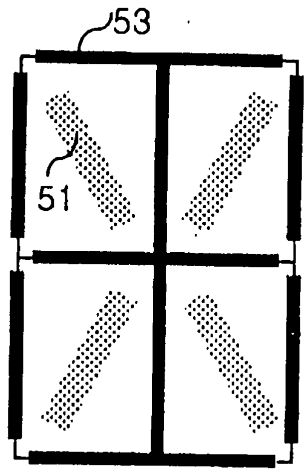


FIG. 36C

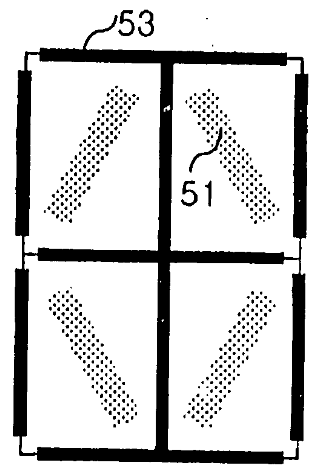
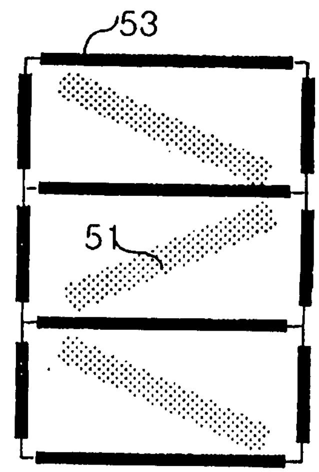


FIG. 36D



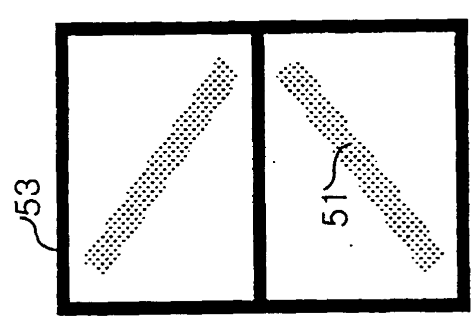


FIG. 36E

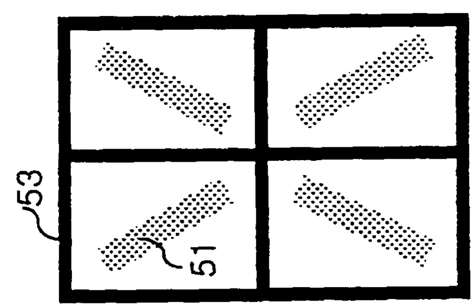


FIG. 36F

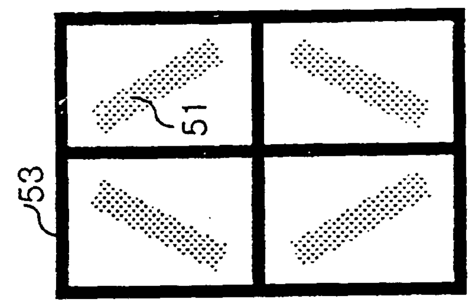


FIG. 36G

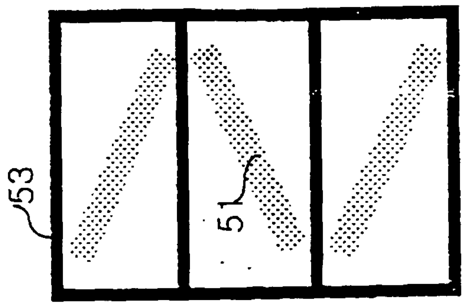


FIG. 36H

FIG. 37A

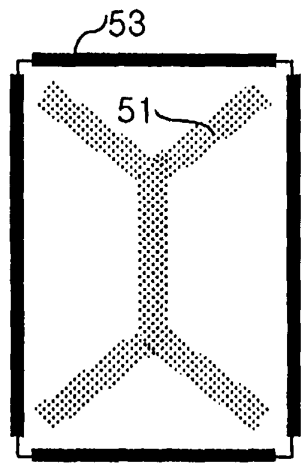
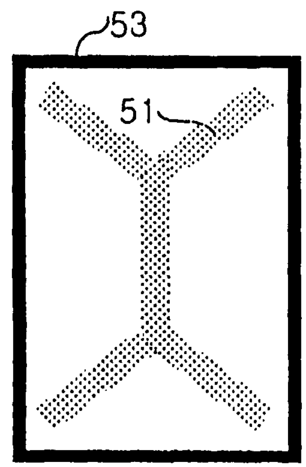


FIG. 37B



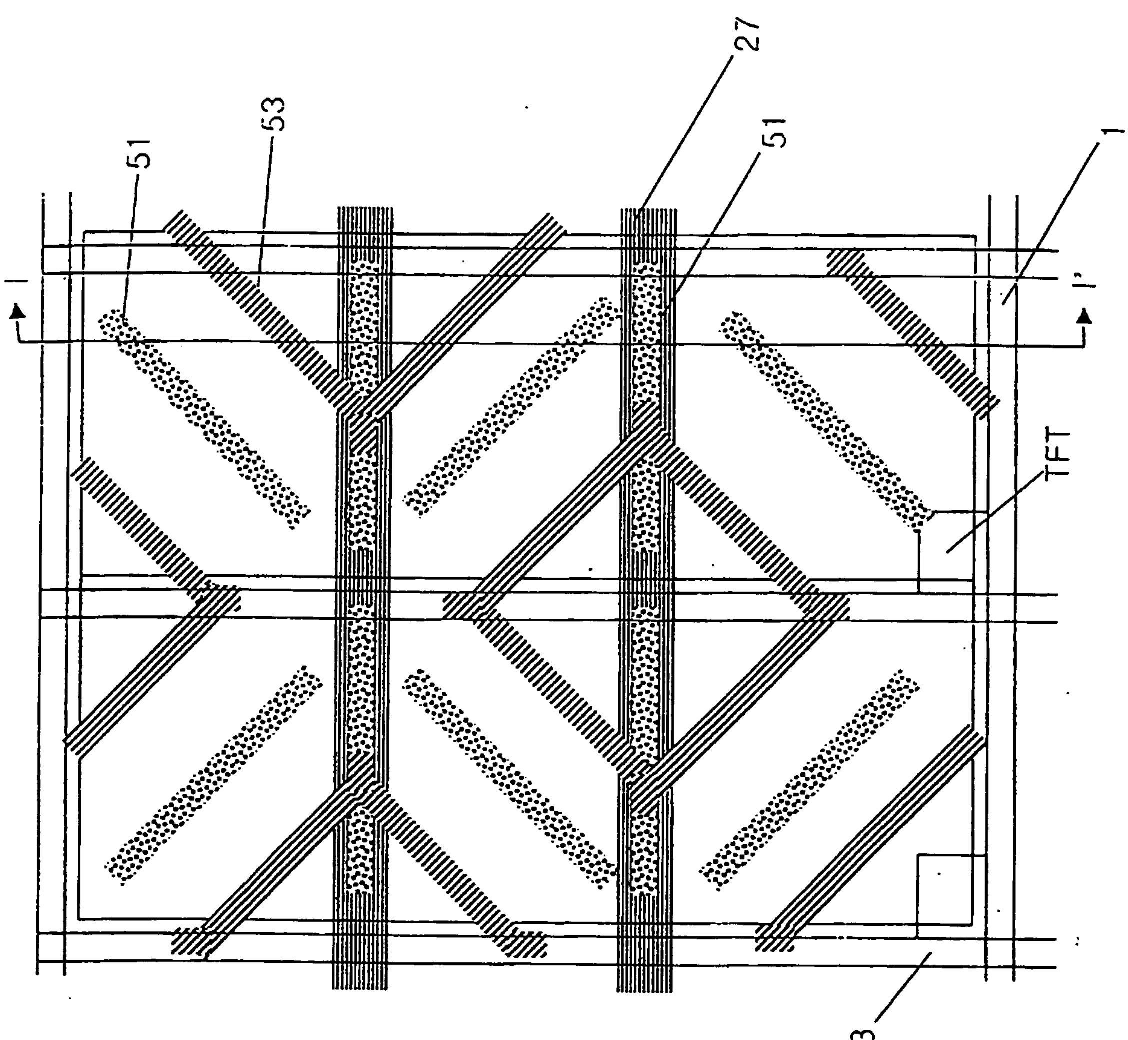


FIG. 38A

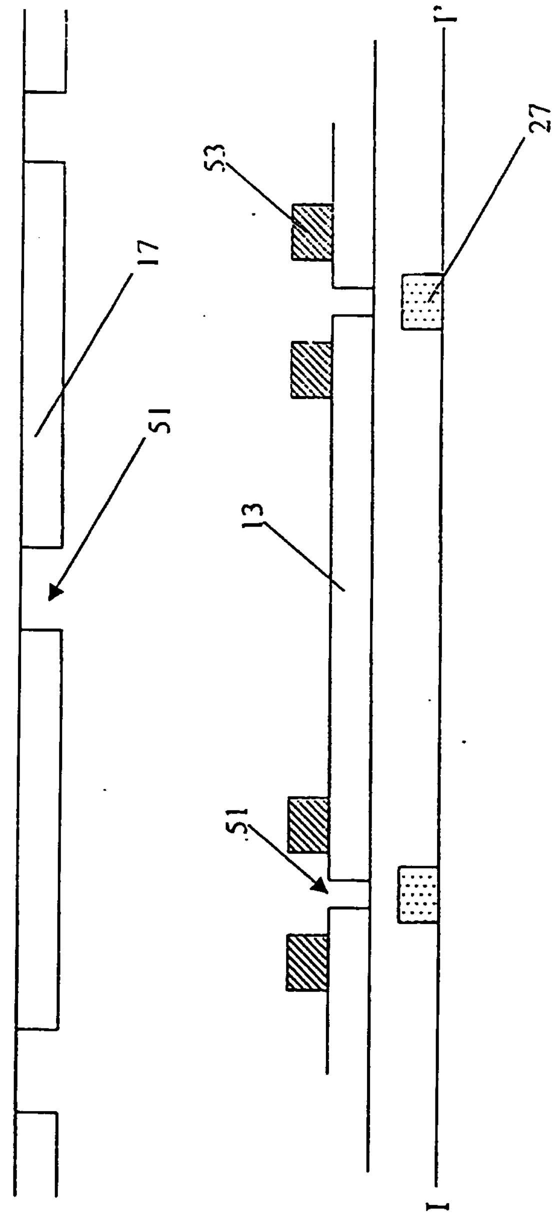


FIG. 38B

2343012

A MULTI-DOMAIN LIQUID CRYSTAL DISPLAY DEVICE

The present invention relates to a liquid crystal display device (LCD), and more particularly, to a liquid crystal display device having dielectric frames on one substrate and electric field inducing window on the same or on the other substrate.

Recently, a LCD has been proposed where the liquid crystal is not aligned, and the liquid crystal is driven by common electrode 17 having open areas 19. Fig. 1 is a sectional view of pixel unit of a conventional LCD.

Regarding conventional LCDs, a plurality of gate bus lines arranged in a first direction on a first substrate and a plurality of data bus lines arranged in a second direction on the first substrate divide the first substrate into a plurality of pixel regions.

A thin film transistor (TFT) applies image signal delivered from the data bus line to a pixel electrode 13 on a passivation layer 4. The TFT is formed on each pixel region and comprises a gate electrode, a gate insulator, a semiconductor layer, an ohmic contact layer, a source electrode, and a drain electrode, etc.

Alternatively, a side electrode 15 is formed to surround the pixel region on the gate insulator, a passivation layer 4 is formed over the whole first substrate, and pixel electrode 13 is formed to overlap the side electrode 15 and is connected to the drain electrode thereon.

On a second substrate, a light shielding layer is formed to shield any light leakage from gate and data bus lines, and the TFT, a color filter layer is formed on the light shielding layer, an overcoat layer is formed on the color filter layer, a common electrode 17 is formed to have open

area 19 on the overcoat layer, and a liquid crystal layer is formed between the first and second substrates.

Pixel electrode 13 and open area (slit) 19 in the common electrode 17 distort the electric field applied to the liquid crystal layer. Then, liquid crystal molecules are driven variously in a unit pixel. This means that when voltage is applied to the LCD, dielectric energy due to the distorted electric field arranges the liquid crystal directors in needed or desired positions.

Fig. 2 is a sectional view of the other liquid crystal display device in the related art. The liquid crystal display device has a smaller pixel electrode 13 than common electrode 17, which induces the distortion of electric field.

In the LCDs, however, open area 19 in common electrode 17 or pixel electrode 13 is necessary, and the liquid crystal molecules could be driven stably when the open area is wider. If the electrodes do not have an open area or the width of the open area is narrow, the electric field distortion needed to divide the pixel region becomes weak.

And, disclination occurs from the area where the liquid crystal directors are parallel with a transmittance axis of the polarizer, which results in a decrease in brightness. Further, according to the surface state of LCDs, the liquid crystal texture has an irregular structure.

Accordingly, the present invention is directed to a LCD that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a multi-domain LCD having wide viewing angle by multi-domain and high brightness by stable arrangement of liquid crystal molecules.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve the objects and in accordance with the purpose of the invention, as embodied and broadly described herein, a multi-domain liquid crystal display device comprises first and second substrates facing each other, a liquid crystal layer between the first and second substrates, a plurality of gate bus lines arranged in a first direction on the first substrate and a plurality of data bus lines arranged in a second direction on the first substrate to define a pixel region, a pixel electrode in the pixel region, a dielectric frame controlling alignment direction of liquid crystal molecules in the liquid crystal layer, a color filter layer on the second substrate, a common electrode on the color filter layer, and an alignment layer on at least one substrate between the first and second substrates.

The common electrode and/or pixel electrode has an electric field inducing window in the inner part thereof.

The dielectric frame is formed surrounding the pixel region or in the pixel region. And, the dielectric constant of the dielectric frame is equal to or lower than dielectric constant of the liquid crystal layer. The dielectric frame includes photosensitive materials, such as photoacrylate and BCB (BenzoCycloButene).

It is to be understood that both the foregoing general description and the following detailed description are

exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

For a better understanding of the present invention, embodiments will now be described by way of example, with reference to the accompanying drawings, in which:

Figs. 1 and 2 are sectional views of the liquid crystal display devices in the related art;

Figs. 3A, 3B, 3C, and 3D are sectional views of the multi-domain liquid crystal display devices according to the first, second, third, and fourth embodiment of the present invention;

Figs. 4A, 4B, and 4C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 5A, 5B, and 5C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 6A, 6B, and 6C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 7A, 7B, and 7C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 8A, 8B, and 8C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 9A, 9B, and 9C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 10A, 10B, and 10C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 11A, 11B, and 11C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 12A, 12B, 12C, and 12D are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 13A, 13B, and 13C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 14A and 14B are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention.

Figs. 15A and 15B are plan and sectional view of the multi-domain liquid crystal display device according to the fifth embodiment of the present invention;

Figs. 16A and 16B, 16C are plan and sectional views of the multi-domain liquid crystal display devices according to the sixth embodiment of the present invention;

Figs. 17A and 17B, 17C are plan and sectional views of the multi-domain liquid crystal display devices according to the seventh embodiment of the present invention;

Figs. 18A and 18B, 18C, 18D, 18E, 18F, 18G are plan and sectional views of the multi-domain liquid crystal display devices according to eighth embodiment of the present invention;

Figs. 19A, 19B, 19C, 19D, 19E, 19F, and 19G are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 20A, 20B, 20C, 20D, 20E, 20F, and 20G are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 21A, 21B, 21C, 21D, 21E, 21F, 21G, 21H, 21I, 21J, 21K, 21L, and 21M are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 22A, 22B, 22C, and 22D are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention;

Figs. 23A, 23B, and 23C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention; and

Figs. 24A, 24B, and 24C are plan views of the multi-domain liquid crystal display devices according to embodiments of the present invention.

Figs. 25A, 25B, 25C, and 25D are sectional views of the multi-domain liquid crystal display devices according to the ninth embodiment of the present invention;

Figs. 26A, 26B, and 26C are sectional views of the multi-domain liquid crystal display devices according to the tenth embodiment of the present invention;

Figs. 27A, 27B, 27C, and 27D are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 28A, 28B, 28C, and 28D are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 29A, 29B, 29C, and 29D are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 30A, 30B, 30C, and 30D are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 31A, 31B, 31C, 31D, 31E, and 31F are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 32A, 32B, and 32C are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 33A, 33B, and 33C are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 34A, 34B, 34C, 34D, 34E, and 34F are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 35A, 35B, 35C, 35D, 35E, and 35F are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 36A, 36B, 36C, 36D, 36E, 36F, 36G, and 36H are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 37A and 37B are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to an embodiment of the present invention;

Figs. 38A and 38B are plan and sectional views of the multi-domain liquid crystal display device according to the eleventh embodiment of the present invention.

Hereinafter, the multi-domain liquid crystal display device of the present invention is explained in detail by accompanying the drawings.

Figs. 3A, 3B, 3C, and 3D are sectional views of the multi-domain liquid crystal display devices according to the first, second, third, and fourth embodiment of the present invention.

As shown in the figures, the display device comprises first and second substrates 31, 33, a plurality of gate bus lines arranged in a first direction on the first substrate and a plurality of data bus lines arranged in a second direction on the first substrate, a TFT, a passivation layer 37 on the whole first substrate 31, a pixel electrode 13, dielectric frames 41, and a first alignment layer on the whole first substrate 31.

On the second substrate 33, a light shielding layer 25 is formed to shield any light leakage from gate and data bus lines, and the TFT, a color filter layer 23 is formed on the light shielding layer, an overcoat layer 29 is formed on the color filter layer 23, a common electrode 17 is formed on the overcoat layer, a second alignment layer on the whole second substrate 33, and a liquid crystal layer is formed between the first and second substrates 31, 33.

The data bus lines and gate bus lines divide the first substrate 31 into a plurality of pixel regions. The TFT is formed on each pixel region and comprises a gate electrode 11, a gate insulator 35, a semiconductor layer 5, an ohmic contact layer, and source/drain electrodes 7, 9. Passivation

layer 37 is formed on the whole first substrate 31, and pixel electrode 13 is coupled to drain electrode 9.

The dielectric frame 41 is controlling alignment direction of liquid crystal molecules of the liquid crystal layer. This is formed on the pixel electrode 13 or the common electrode 17, and it is possible to form the dielectric frame on both substrates.

To manufacture the multi-domain LCD, in each pixel region on the first substrate 31, a TFT is formed comprising gate electrode 11, gate insulator 35, semiconductor layer 5, ohmic contact layer 6 and source/drain electrodes 7, 9. At this time, a plurality of gate bus lines and a plurality of data bus lines are formed to divide the first substrate 31 into a plurality of pixel regions.

Gate electrode 11 and gate bus line are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc. Alternatively, it is possible to form the gate electrode and gate bus line as a double layer, the double layer is formed from different materials.

The gate insulator 35 is formed by depositing SiN_x or SiO_x using PECVD (Plasma Enhancement Chemical Vapor Deposition) thereon. Semiconductor layer 5 and the ohmic contact layer are formed by depositing with PECVD and patterning amorphous silicon (a-Si) and doped amorphous silicon (n^+ a-Si), respectively. Also, SiN_x or SiO_x and a-Si, n^+ a-Si are formed by depositing with PECVD, the gate insulator 35 is formed and the semiconductor layer 5 and the ohmic contact layer 6 are formed by patterning.

Data bus line and source/drain electrodes 7, 9 are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc. Alternatively, it is possible to form

the data bus line and source/drain electrodes as a double layer, the double layer is formed from different materials.

A storage electrode (not shown in the figures) is formed to overlap gate bus line and to connect to the pixel electrode 13 at the same time, the storage electrode makes a storage capacitor with the gate bus line 1.

Subsequently, passivation layer 37 is formed with BCB (BenzoCycloButene), acrylic resin, polyimide based material, SiN_x or SiO_x on the whole first substrate 31. Pixel electrode 13 is formed by sputtering and patterning a metal such as ITO (Indium Tin Oxide), Al or Cr. A contact hole 39 is formed to connect the pixel electrode 13 to the drain and storage electrodes by opening and patterning a part of the passivation layer 37 on drain electrode 9.

On the second substrate 33, a light shielding layer 25 is formed to shield any light leakage from gate and data bus lines, and the TFT. A color filter layer 23 is formed R, G, B (red, green, blue) elements to alternate on the light shielding layer 25. On the color filter layer 23, overcoat layer 29 is formed with resin. A common electrode 17 is formed with ITO on the overcoat layer.

And, a liquid crystal layer is formed by injecting liquid crystal between the first and second substrates 31, 33. The liquid crystal layer may include liquid crystal molecules having positive 'or negative dielectric anisotropy. Also, the liquid crystal layer may include chiral dopants.

A dielectric frame 41 is formed by depositing photosensitive material on the common electrode 17 or pixel electrode 13 and patterning in various shapes using photolithography. The dielectric frame 41 includes material of which dielectric constant is same or smaller than that of the liquid crystal, and the dielectric constant thereof is

preferably below 3, for example, photoacrylate or BCB (BenzoCycloButene).

Furthermore, the dielectric frame 41 is formed on at least one substrate between the first and second substrates 31, 33 (refer to Figs. 3A, 3B and 3C, 3D). And, an electric field inducing window 43 is formed on at least one substrate between the first and second substrates 31, 33 (refer to Figs. 3B and 3D).

At this time, the dielectric frame 41 and electric field inducing window 43 are formed on same substrate together. The electric field inducing window 43 is formed by patterning the common electrode 17 or pixel electrode 13.

As shown in Figs. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 are plan views showing the various dielectric frames 41 and electric field inducing windows 43 of the multi-domain liquid crystal display devices according to embodiments of the present invention. The solid lined-arrow represents the alignment direction of the second substrate, and the dotted lined-arrow represents the alignment direction of the first substrate.

As shown in the Figures, the dielectric frame 41 and the electric field inducing window 43 are patterned in various shapes, which obtains multi-domain effect. The electric field inducing window 43 may be a slit or hole. Furthermore, neighboring two pixels and two alignment directions are associated, which obtains multi-domain effect.

From forming electric field inducing window 43, the multi-domain is obtained by dividing each pixel into four domains such as in a "+", "x", or "double Y" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

On at least one substrate, a compensation film 29 is formed with polymer. The compensation film 29 is a negative uniaxial film, which has one optical axis, and compensates the phase difference of the direction according to viewing-angle. Hence, it is possible to compensate effectively the right-left viewing-angle by widening the area without gray inversion, increasing contrast ratio in an inclined direction, and forming one pixel to multi-domain.

In the present multi-domain liquid crystal display device, it is possible to form a negative biaxial film as the compensation film 29, which has two optical axes and has wider viewing-angle characteristics as compared with the negative uniaxial film. The compensation film 29 could be formed on both substrates or on one of them.

After forming the compensation film 29, polarizer is formed on at least one substrate. At this time, the compensation film 29 and polarizer are preferably composed as one.

In the present LCD, the liquid crystal layer includes liquid crystal molecules having negative dielectric anisotropy, which applies a homeotropic alignment where liquid crystal molecules in the liquid crystal layer are aligned homeotropically to surfaces of the first and second substrates.

In the multi-domain LCD an alignment layer (not shown in the figure) is formed over the whole first and/or second substrates. The alignment layer includes a material such as polyamide or polyimide based materials, PVA (polyvinylalcohol), polyamic acid or SiO_2. When rubbing is used to determine an alignment direction, it should be possible to apply any material suitable for the rubbing treatment.

Moreover, it is possible to form the alignment layer with a photosensitive material such as PVCN (polyvinylcinnamate), PSCN (polysiloxanecinnamate), and CelCN (cellulosecinnamate) based materials. Any material suitable for the photo-aligning treatment may be used.

Irradiating light once on the alignment layer determines the alignment or pretilt direction and the pretilt angle. The light used in the photo-alignment is preferably a light in a range of ultraviolet light, and any of unpolarized light, linearly polarized light, and partially polarized light can be used.

In the rubbing or photo-alignment treatment, it is possible to apply one or both of the first and second substrates, and to apply different aligning-treatment on each substrate.

From the aligning-treatment, a multi-domain LCD is formed with at least two domains, and LC molecules of the LC layer are aligned differently one another on each domain. That is, the multi-domain is obtained by dividing each pixel into four domains such as in a "+" or "x" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

It is possible to have at least one domain of the divided domains unaligned. It is also possible to have all domains unaligned.

Consequently, the multi-domain LCD forms dielectric frames of which dielectric constant is different from that of liquid crystal, and electric field inducing window to distort electric field, thereby wide viewing angle is obtained.

Furthermore, in the case of conducting an alignment-treatment, a high response time and a stable LC structure can be obtained by a pretilt angle and an anchoring energy.

Figs. 15A and 15B are plan and sectional view of the multi-domain liquid crystal display device according to the fifth embodiment of the present invention, Figs. 16A, and 16B, 16C are plan and sectional views of the multi-domain liquid crystal display devices according to the sixth embodiment of the present invention, Figs. 17A and 17B, 17C are plan and sectional views of the multi-domain liquid crystal display devices according to the seventh embodiment of the present invention, and Figs. 18A and 18B, 18C, 18D, 18E, 18F, 18G are plan and sectional views of the multi-domain liquid crystal display devices according to eighth embodiment of the present invention.

As shown in the figures, the display device comprises first and second substrates 31, 33, a plurality of gate bus lines arranged in a first direction on the first substrate and a plurality of data bus lines arranged in a second direction on the first substrate, a TFT, a passivation layer 37 on the whole first substrate 31, a pixel electrode 13, and a first alignment layer 53 on the whole first substrate.

On a second substrate, a light shielding layer 25 is formed to shield any light leakage from gate and data bus lines, and the TFT, a color filter layer 23 is formed on the light shielding layer, a common electrode 17 is formed on the color filter layer, a dielectric frame 57 to distort electric field on the common electrode 17, a second alignment layer 55 on the whole second substrate, and a liquid crystal layer is formed between the first and second substrates.

Data bus lines and gate bus lines divide the first substrate 31 into a plurality of pixel regions. The TFT is

formed on each pixel region and comprises a gate electrode 11, a gate insulator 35, a semiconductor layer 5, an ohmic contact layer, and source/drain electrodes 7, 9. Passivation layer 37 is formed on the whole first substrate and pixel electrode 13 is coupled to drain electrode 9.

To manufacture the multi-domain LCD, in each pixel region on the first substrate 31, a TFT is formed comprising gate electrode 11, gate insulator 35, semiconductor layer 5, ohmic contact layer and source/drain electrodes 7, 9. At this time, a plurality of gate bus lines and a plurality of data bus lines are formed to divide the first substrate 31 into a plurality of pixel regions.

Gate electrode 11 and gate bus line are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc. The gate insulator 35 is formed by depositing SiN_x or SiO_x using PECVD (Plasma Enhancement Chemical Vapor Deposition) thereon. Semiconductor layer 5 and the ohmic contact layer are formed by depositing with PECVD and patterning amorphous silicon (a-Si) and doped amorphous silicon (n^+ a-Si), respectively. Also, SiN_x or SiO_x and a-Si, n^+ a-Si are formed by depositing with PECVD, the gate insulator 35 is formed and semiconductor layer 5 and the ohmic contact layer 6 are formed by patterning. Data bus line and source/drain electrodes 7, 9 are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc.

A storage electrode (not shown in the figures) is formed to overlap gate bus line and to connect to the pixel electrode 13 at the same time, the storage electrode makes a storage capacitor with the gate bus line.

Subsequently, passivation layer 37 is formed with BCB (BenzoCycloButene), acrylic resin, polyimide based material,

SiN_x or SiO_x on the whole first substrate 31. Pixel electrode 13 is formed by sputtering and patterning a metal such as ITO(indium tin oxide). A contact hole 39 is formed to connect the pixel electrode 13 to the drain and storage electrodes by opening and patterning a part of the passivation layer 37 on drain electrode 9.

On the second substrate 33, a light shielding layer 25 is formed to shield any light leakage from gate and data bus lines, and the TFT. A color filter layer 23 is formed R, G, B (red, green, blue) elements to alternate on the light shielding layer. A common electrode 17 is formed with ITO on the color filter layer. A dielectric frame 57 is formed by depositing photosensitive material on the common electrode 17 or pixel electrode 13 and patterning in various shapes using photolithography. And, a liquid crystal layer is formed by injecting liquid crystal between the first and second substrates.

The dielectric frame 57 includes material of which dielectric constant is same or smaller than that of the liquid crystal, and the dielectric constant thereof is preferably below 3, for example, photoacrylate or BCB (BenzoCycloButene).

Furthermore, the dielectric frame 57 is also used as a spacer (refer to Figs. 15B, 16C, 17C, 18C, 18E, and 18G). Dielectric frame 57 is formed on at least one substrate between the first and second substrates. In these embodiments, a spacer dispersing process could be omitted and the gap uniformity of liquid crystal cell is enhanced, therefore, the yield is improved.

And, an electric field inducing window 43 is formed on at least one substrate between the first and second substrates (refer to Figs. 17B and 18F, 18G). At this time,

the dielectric frame and electric field inducing window are formed on same substrate together. The electric field inducing window 43 is formed in various shapes by patterning hole or slit in the common electrode 17 or pixel electrode 13.

As an embodiment in multi-domain LCD of the present invention, an auxiliary electrode 27 is additionally formed in an area except the pixel region. (refer to Figs. 16A and 18A) The auxiliary electrode 27 is formed on a layer whereon the pixel electrode 17 or gate electrode 11 is formed, and electrically connected to the common electrode 17. (refer to Figs. 16B, 16C and 18D, 18E)

The auxiliary electrodes 27 is formed by sputtering and patterning a metal such as ITO(indium tin oxide), Al, Mo, Cr, Ta, Ti or Al alloy. At this time, it is possible to form the auxiliary and pixel electrodes 27, 13 by patterning the same metal once or by patterning different metals twice.

As shown in Figs. 20, 22, 23, and 24, the auxiliary electrode 27 can be formed as surrounding the pixel electrode 13, in the side of data bus line and/or in the side of gate bus line.

Fig. 18 shows that the light shielding layer 25 is formed on the first substrate 31, Figs. 18D and 18E show that the auxiliary electrode 27 is formed on a layer whereon the pixel electrode 17 is formed. In these embodiments, the light shielding layer is formed to adjust exactly the pixel region, hence, the lamination margin is reduced and the aperture ratio is enhanced than the light shielding layer is formed on the second substrate.

On at least one substrate, a compensation film 29 is formed with polymer. The compensation film is a negative uniaxial film, which has one optical axis, and compensates

the phase difference of the direction according to viewing-angle. Hence, it is possible to compensate effectively the right-left viewing-angle by widening the area without gray inversion, increasing contrast ratio in an inclined direction, and forming one pixel to multi-domain.

In the present multi-domain liquid crystal display device, it is possible to form a negative biaxial film as the compensation film 29, which has two optical axes and has wider viewing-angle characteristics as compared with the negative uniaxial film. The compensation film could be formed on both substrates or on one of them.

After forming the compensation film 29, polarizer is formed on at least one substrate. At this time, the compensation film and polarizer are preferably composed as one.

In the Figs. 19A to 19G, the dielectric frame 57 is patterned in various shapes, which obtains multi-domain effect.

In the Figs. 20A to 20G, the auxiliary electrode 27 is formed surrounding pixel electrode 13, and the dielectric frame 57 is patterned in various shapes, which obtains multi-domain effect.

In the Figs. 21A to 21M, the electric field inducing window 43 is formed, and the dielectric frame 57 is patterned in various shapes, which obtains multi-domain effect. The electric field inducing window 43 may be a slit or hole.

In the LCD in Figs. 19 to 21, the liquid crystal layer includes liquid crystal molecules having negative dielectric anisotropy, which applies a homeotropic alignment where liquid crystal molecules in the liquid crystal layer are aligned homeotropically to surfaces of the first and second substrates.

In the Figs. 22A, 22B, 22C, and 22D, the auxiliary electrode 27 is formed, and the dielectric frame 57 is patterned in various shapes, which obtains multi-domain effect. Although not shown in the figures, there are embodiments that do not form the auxiliary electrode 27.

The solid lined-arrow 63 presents the rubbing direction of the second substrate 33 and the dotted lined-arrow 61 presents the rubbing direction of the first substrate 31.

In the Figs. 23A, 23B, and 23C, the auxiliary electrode 27 is formed, and the dielectric frame 57 is patterned in various shapes. Furthermore, neighboring two pixels and two alignment directions are associated, which obtains multi-domain effect. Although not shown in the figures, there are embodiments that do not form the auxiliary electrode 27.

The solid lined-arrow 67 presents the alignment direction of the second substrate 33 and the dotted lined-arrow 65 presents the alignment direction of the first substrate 31.

In the Figs. 24A, 24B, and 24C, the auxiliary electrode 27 is formed, and the dielectric frame 57 is patterned in various shapes. Furthermore, neighboring two pixels and two alignment directions are associated being different from that in the Fig. 23, which obtains multi-domain effect. Although not shown in the figures, there are embodiments that do not form the auxiliary electrode 27.

In the LCD in Figs. 22 to 24, the liquid crystal layer includes liquid crystal molecules having positive dielectric anisotropy, which applies a homogeneous alignment where liquid crystal molecules in the liquid crystal layer are aligned homogeneously to surfaces of the first and second substrates.

From forming the electric field inducing window or dielectric frame, the multi-domain is obtained by dividing each pixel into four domains such as in a "+", "x", or "double Y" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

Furthermore, in the multi-domain LCD, the first and second alignment layers are formed over the whole first and/or second substrates. The alignment layer includes a material such as polyamide or polyimide based materials, PVA (polyvinylalcohol), polyamic acid or SiO_2. When rubbing is used to determine an alignment direction, it should be possible to apply any material suitable for the rubbing treatment.

Moreover, it is possible to form the alignment layer with a photosensitive material such as PVCN (polyvinylcinnamate), PSCN (polysiloxanecinnamate), and CelCN (cellulosecinnamate) based materials. Any material suitable for the photo-aligning treatment may be used. Irradiating light once on the alignment layer determines the alignment or pretilt direction and the pretilt angle. The light used in the photo-alignment is preferably a light in a range of ultraviolet light, and any of unpolarized light, linearly polarized light, and partially polarized light can be used.

In the rubbing or photo-alignment treatment, it is possible to apply one or both of the first and second substrates, and to apply different aligning-treatment on each substrate.

From the aligning-treatment, a multi-domain LCD is formed with at least two domains, and LC molecules of the LC layer are aligned differently one another on each domain.

That is, the multi-domain is obtained by dividing each pixel into four domains such as in a "+" or "x" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

It is possible to have at least one domain of the divided domains unaligned. It is also possible to have all domains unaligned.

Consequently, the multi-domain LCD forms dielectric frames of which dielectric constant is different from that of liquid crystal, and auxiliary electrode or electric field inducing window to distort electric field, thereby wide viewing angle is obtained.

Also, the dielectric frame is patterned as a spacer, which can leave out the spacer process in the conventional LCD processes.

Furthermore, in the case of conducting an alignment-treatment, a high response time and a stable LC structure can be obtained by a pretilt angle and an anchoring energy.

Figs. 25A, 25B, 25C, and 25D are sectional views of the multi-domain liquid crystal display devices according to the ninth embodiment of the present invention and Figs. 26A, 26B, and 26C are sectional views of the multi-domain liquid crystal display devices according to the tenth embodiment of the present invention.

As shown in the figures, the display device comprises first and second substrates 31, 33, a plurality of gate bus lines 1 arranged in a first direction on a first substrate and a plurality of data bus lines 3 arranged in a second direction on the first substrate, a TFT, a passivation layer 37, and a pixel electrode 13.

On the second substrate 33, a light shielding layer 25 is formed to shield the light leaked from gate and data bus lines 1, 3, and the TFT, a color filter layer 23 is formed on the light shielding layer, a common electrode 17 is formed on the color filter layer, a dielectric frame in a region other than the pixel region, and a liquid crystal layer is formed between the first and second substrates.

Data bus lines 3 and gate bus lines 1 divide the first substrate 31 into a plurality of pixel regions. The TFT is formed on each pixel region and comprises a gate electrode 11, a gate insulator 35, a semiconductor layer 5, an ohmic contact layer 6, and source/drain electrodes 7, 9. Passivation layer 37 is formed on the whole first substrate 31. Pixel electrode 13 is coupled to the drain electrode 9.

To manufacture the multi-domain LCD, in each pixel region on the first substrate 31, a TFT is formed comprising gate electrode 11, gate insulator 35, semiconductor layer 5, ohmic contact layer 6 and source/drain electrodes 7, 9. At this time, a plurality of gate bus lines 1 and a plurality of data bus lines 3 are formed to divide the first substrate 31 into a plurality of pixel regions.

Gate electrode 11 and gate bus line 1 are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc. Alternatively, it is possible to form the gate electrode and gate bus line as a double layer, the double layer is formed from different materials.

The gate insulator 35 is formed by depositing SiN_x, SiO_x, or BCB (BenzoCycloButene), acrylic resin using PECVD thereon. Semiconductor layer 5 and the ohmic contact layer 6 are formed by depositing with PECVD(Plasma Enhancement Chemical Vapor Deposition) and patterning amorphous silicon (a-Si) and doped amorphous silicon (n^+ a-Si), respectively.

Also, SiN_x or SiO_x and a-Si, n^+ a-Si are formed by depositing with PECVD, the gate insulator 35 is formed and the semiconductor layer 5 and the ohmic contact layer 6 are formed by patterning.

Data bus line 3 and source/drain electrodes 7, 9 are formed by sputtering and patterning a metal such as Al, Mo, Cr, Ta, Al alloy, etc. Alternatively, it is possible to form the data bus line and source/drain electrodes as a double layer, the double layer is formed from different materials.

A storage electrode (not shown in the figures) is formed to overlap gate bus line 1, the storage electrode makes a storage capacitor with gate bus line 1.

Subsequently, passivation layer 37 is formed with BCB (BenzoCycloButene), acrylic resin, polyimide based material, SiN_x or SiO_x on the whole first substrate. Pixel electrode 13 is formed by sputtering and patterning a metal such as ITO(indium tin oxide). A contact hole 39 is formed to connect the pixel electrode 13 to the drain 9 and storage electrodes by opening and patterning a part of the passivation layer 37 on drain electrode 9.

On the second substrate 33, a light shielding layer 25 is formed to shield any light leakage from gate and data bus lines 1, 3, and the TFT. A color filter layer 23 is formed R, G, B (red, green, blue) elements to alternate on the light shielding layer 25.

A common electrode 17 is formed with ITO on the color filter layer 23, and a liquid crystal layer is formed by injecting liquid crystal between the first and second substrates. The liquid crystal layer may include liquid crystal molecules having positive or negative dielectric anisotropy. Also, the liquid crystal layer may include chiral dopants.

On at least one substrate between the first and second substrates, a dielectric frame 53 is formed by depositing photosensitive material in a region other than a region where the pixel electrode 13 is formed and patterning in various shapes using photolithography.

The dielectric frame 53 includes material of which dielectric constant is same or smaller than that of the liquid crystal, and the dielectric constant thereof is preferably below 3, for example, photoacrylate or BCB (BenzoCycloButene).

As an embodiment, the dielectric frame could include mixture of polyimide and carbon black or mixture of acrylic resin and carbon black. And then, the dielectric frame shields light leakage from an area except the pixel region and distorts the electric field applied to the liquid crystal layer. In this case, the dielectric constant of the liquid crystal layer is about 4, preferably the dielectric constant of the dielectric frame is below 3.5.

On the other hand, as shown in the figures 26A, 26B, and 26C, the dielectric frame is also used as a spacer to maintain uniformly gap between the first and second substrates.

Furthermore, the dielectric frame 53 is formed on at least one substrate between the first and second substrates. And, an electric field inducing window 51 is formed on at least one substrate between the first and second substrates.

At this time, the dielectric frame 53 and electric field inducing window 51 could be formed on same substrate together. The electric field inducing window 51 is formed by patterning the common electrode 17 or pixel electrode 13.

On at least one substrate, a compensation film 29 is formed with polymer. The compensation film is a negative

uniaxial film, which has one optical axis, and compensates the phase difference of the direction according to viewing-angle. Hence, it is possible to compensate effectively the right-left viewing-angle by widening the area without gray inversion, increasing contrast ratio in an inclined direction, and forming one pixel to multi-domain.

In the present multi-domain liquid crystal display device, it is possible to form a negative biaxial film as the compensation film, which has two optical axes and wider viewing-angle characteristics as compared with the negative uniaxial film. The compensation film could be formed on both substrates or on one of them.

After forming the compensation film, polarizer is formed on at least one substrate. At this time, the compensation film and polarizer are preferably composed as one.

In the multi-domain LCD, the aperture ratio is enhanced by an optimum structure design of a "n-line" thin film transistor (USP 5,694,185) so as to reduce power consumption, increase luminance, and lower reflection, thus improving contrast ratio. Aperture ratio is increased by forming the TFT above the gate line and providing a "n-line" TFT. The parasitic capacitor, occurring between the gate bus line and the drain electrode, can be reduced when a TFT having the same channel length as the symmetrical TFT structure is manufactured due to effect of channel length extension.

The multi-domain LCD has a dielectric frame 53 on the pixel electrode and/or common electrode, or an electric field inducing window 51 like a hole or slit in the pixel electrode, passivation layer, gate insulator, color filter layer, and/or common electrode by patterning, thereby electric field distortion effect and multi-domain are obtained.

That is, from forming electric field inducing window 51 or dielectric frame 53, the multi-domain is obtained by dividing each pixel into four domains such as in a "+", "x", or "double Y" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

Figs. 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, and 37 are plan views showing various electric field inducing window and dielectric frame of the multi-domain liquid crystal display devices according to embodiments of the present invention. In the figures, the solid lined-arrow represents an alignment direction of the second substrate, and the dotted lined-arrow represents an alignment direction of the first substrate.

Further, the dielectric frame 53 and at least one electric field inducing window 51 are patterned in various shapes, which obtains multi-domain effect. The electric field inducing window may be a slit or hole. Furthermore, neighboring two pixels and two alignment directions are associated, which obtains multi-domain effect.

Figs. 38A and 38B are plan and sectional views of the multi-domain liquid crystal display device according to the eleventh embodiment of the present invention.

As shown in the figures, the eleventh embodiment of the present invention has a plurality of dielectric frames 53 having a zigzag shape in a pixel on one substrate between the first and second substrates. And a plurality of electric field inducing windows 51 are formed in various shapes on the first and second substrate. In addition, a plurality of auxiliary electrodes 27 were formed corresponding to the electric field inducing windows 51 of the pixel electrode 13 on the same layer where the gate bus lines were formed.

In multi-domain LCD, an alignment layer (not shown in the figure) is formed over the whole first and/or second substrates. The alignment layer includes a material such as polyamide or polyimide based materials, PVA (polyvinylalcohol), polyamic acid or SiO_2. When rubbing is used to determine an alignment direction, it should be possible to apply any material suitable for the rubbing treatment.

Moreover, it is possible to form the alignment layer with a photosensitive material such as PVCN (polyvinylcinnamate), PSCN (polysiloxanecinnamate), and CelCN (cellulosecinnamate) based materials. Any material suitable for the photo-aligning treatment may be used.

Irradiating light once on the alignment layer determines the alignment or pretilt direction and the pretilt angle. The light used in the photo-alignment is preferably a light in a range of ultraviolet light, and any of unpolarized light, linearly polarized light, and partially polarized light can be used.

In the rubbing or photo-alignment treatment, it is possible to apply one or both of the first and second substrates, and to apply different aligning-treatment on each substrate.

From the aligning-treatment, a multi-domain LCD is formed with at least two domains, and LC molecules of the LC layer are aligned differently one another on each domain. That is, the multi-domain is obtained by dividing each pixel into four domains such as in a "+" or "x" shape, or dividing each pixel horizontally, vertically, and/or diagonally, and differently alignment-treating or forming alignment directions on each domain and on each substrate.

It is possible to have at least one domain of the divided domains unaligned. It is also possible to have all domains unaligned.

Consequently, since the multi-domain LCD forms the dielectric frame in a region except the pixel region and the electric field inducing window in the pixel region, electric field is distorted and multi-domain effect is obtained.

Moreover, the dielectric frame is used as a light shielding layer or spacer, which could obtain simplify of manufacturing processes and a high aperture ratio.

Also, in the case of conducting an alignment-treatment, a high response time and a stable LC structure can be obtained by a pretilt angle and an anchoring energy. Moreover, the disclination is thus removed to thereby improve the brightness.

It will be apparent to those skilled in the art that various modifications can be made in the liquid crystal display device of the present invention without departing from the sprit or scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims:

1. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode in said pixel region;

a dielectric frame controlling alignment direction of liquid crystal molecules in said liquid crystal layer;

a light shielding layer on said second substrate;

a color filter layer on said light shielding layer;

a common electrode on said color filter layer; and an alignment layer on at least one substrate between said first and second substrates.

2. The multi-domain liquid crystal display device according to claim 1 , wherein said common electrode has an electric field inducing window in an inner part thereof.

3. The multi-domain liquid crystal display device according to claim 1 or 2, wherein said pixel electrode has an electric field inducing window in an inner part thereof.

4. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame surrounds said pixel region.

5. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame is formed in said pixel region.

6. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame is formed on said pixel electrode.

7. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame is formed on said common electrode.

8. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame is formed in an area in which said light shielding layer is formed.

9. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein dielectric constant of said dielectric frame is equal to or lower than dielectric constant of said liquid crystal layer.

10. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said dielectric frame includes a material selected from the group consisting of photoacrylate and BCB (BenzoCycloButene).

11. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said pixel region is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being driven differently from each other.

12. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said alignment layer is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being aligned differently from each other.

13. The multi-domain liquid crystal display device according to claim 12, wherein at least one portion of said alignment layer is alignment-treated.

14. The multi-domain liquid crystal display device according to claim 12, wherein all portions of said alignment layer are non-alignment-treated.

15. The multi-domain liquid crystal display device according to claim 12, 13 or 14, wherein at least one portion of said alignment layer is rubbing-treated.

16. The multi-domain liquid crystal display device according to claim 15, wherein said alignment layer includes a material selected from the group consisting of polyimide and polyamide based materials, PVA (polyvinylalcohol), polyamic acid, and silicon dioxide.

17. The multi-domain liquid crystal display device according to claim 12, 13 or 14, wherein at least one portion of said alignment layer is photo-alignment-treated.

18. The multi-domain liquid crystal display device according to claim 17, wherein said alignment layer includes a material selected from the group consisting of PVCN

(polyvinylcinnamate), PSCN (polysiloxanecinnamate), and CelCN (cellulosecinnamate) based materials.

19. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said liquid crystal layer includes liquid crystal molecules having positive dielectric anisotropy.

20. The multi-domain liquid crystal display device according to any one of claims 1 to 18, wherein said liquid crystal layer includes liquid crystal molecules having negative dielectric anisotropy.

21. The multi-domain liquid crystal display device according to any one of the preceding claims, wherein said liquid crystal layer includes chiral dopants.

22. The multi-domain liquid crystal display device according to any one of the preceding claims, further comprising: a negative uniaxial film on at least one substrate between said first and second substrates.

23. The multi-domain liquid crystal display device according to any one of claims 1 to 21, further comprising: a negative biaxial film on at least one substrate between said first and second substrates.

24. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a pixel electrode on said first substrate;

a common electrode on said second substrate; and

a dielectric frame controlling alignment direction of liquid crystal molecules in said liquid crystal layer.

25. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode electrically charged through said data bus line in said pixel region;

a color filter layer on said second substrate;

a common electrode on said color filter layer;

dielectric frames in said pixel region;

an auxiliary electrode in an area except said pixel region; and

an alignment layer on at least one substrate between said first and second substrates.

26. The multi-domain liquid crystal display device according to claim 25, wherein said auxiliary electrode is on a layer on which said pixel electrode is formed.

27. The multi-domain liquid crystal display device according to claim 25 or 26, wherein said auxiliary electrode is on a layer on which said gate bus lines are formed.

28. The multi-domain liquid crystal display device according to any one of claims 25 to 27, wherein said auxiliary electrode is electrically connected to said common electrode.

29. The multi-domain liquid crystal display device according to any one of claims 25 to 28, wherein said auxiliary electrode includes a material selected from the group consisting of ITO (indium tin oxide), aluminum, molybdenum, chromium, tantalum, titanium, and an alloy thereof.

30. The multi-domain liquid crystal display device according to any one of claims 25 to 29, wherein said common electrode has an electric field inducing window inside of itself.

31. The multi-domain liquid crystal display device according to any one of claims 25 to 30, wherein said pixel electrode has an electric field inducing window inside of itself.

32. The multi-domain liquid crystal display device according to any one of claims 25 to 31, wherein said pixel region is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being driven differently from each other.

33. The multi-domain liquid crystal display device according to any one of claims 25 to 32, wherein said alignment layer is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being aligned differently from each other.

34. The multi-domain liquid crystal display device according to any one of claims 25 to 33, wherein said dielectric frame is a spacer.

35. The multi-domain liquid crystal display device according to any one of claims 25 to 34, further comprising:

a light shielding layer on said first substrate.

36. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode electrically charged through said data bus line in said pixel region;

a light shielding layer in an area except said pixel region on said first substrate;

a color filter layer on said second substrate;

a common electrode on said color filter layer;

dielectric frames in said pixel region; and

an alignment layer on at least one substrate between said first and second substrates.

37. The multi-domain liquid crystal display device according to claim 36, further comprising:

an auxiliary electrode in an area except said pixel region.

38. The multi-domain liquid crystal display device according to claim 36 or 37, wherein said common electrode has an electric field inducing window inside of itself.

39. The multi-domain liquid crystal display device according to claim 36, 37 or 38, wherein said pixel electrode has an electric field inducing window inside of itself.

40. The multi-domain liquid crystal display device according to claim 36, 37, 38 or 39, wherein said dielectric frame is a spacer.

41. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode electrically charged through said data bus line in said pixel region;

a color filter layer on said second substrate;

a common electrode on said color filter layer;

dielectric frames in said pixel region;

an electric field inducing window in said pixel region; and

an alignment layer on at least one substrate between said first and second substrates.

42. The multi-domain liquid crystal display device according to claim 41, further comprising:

an auxiliary electrode in an area except said pixel region.

43. The multi-domain liquid crystal display device according to claim 41 or 42, wherein said dielectric frame is a spacer.

44. The multi-domain liquid crystal display device according to claim 41, 42 or 43, further comprising:

a light shielding layer in an area except said pixel region on said first substrate.

45. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode electrically charged through said data bus line in said pixel region;

a color filter layer on said second substrate;

a common electrode on said color filter layer;

dielectric frames in said pixel region as a spacer; and

an alignment layer on at least one substrate between said first and second substrates.

46. The multi-domain liquid crystal display device according to claim 45, wherein said common electrode has an electric field inducing window inside of itself.

47. The multi-domain liquid crystal display device according to claim 45 or 46, wherein said pixel electrode has an electric field inducing window inside of itself.

48. The multi-domain liquid crystal display device according to claim 45, 46 or 47, further comprising:

an auxiliary electrode in an area except said pixel region.

49. The multi-domain liquid crystal display device according to claim 45, 46, 47 or 48, further comprising:

a light shielding layer in an area except said pixel region on said first substrate.

50. A multi-domain liquid crystal display device comprising:

a plurality of data bus lines in which data signal is provided;

a plurality of gate bus lines crossed said data bus lines to define a pixel region;

a pixel electrode driving a liquid crystal layer;

dielectric frames in said pixel region; and

a light shielding layer in an area except said pixel region.

51. The multi-domain liquid crystal display device according to claim 50, further comprising:

an auxiliary electrode in an area except said pixel region.

52. The multi-domain liquid crystal display device according to claim 50, further comprising:

an electric field inducing window in said pixel region.

53. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode in said pixel region;

a dielectric frame in a region other than a region where said pixel electrode is formed, said dielectric frame distorting electric field applied to said liquid crystal layer;

a common electrode on said second substrate; and

an alignment layer on at least one substrate between said first and second substrates.

54. The multi-domain liquid crystal display device according to claim 53, further comprising;

a gate insulator over said whole first substrate;

a passivation layer on said gate insulator over said whole first substrate;

a light shielding layer on said second substrate;

a color filter layer on said light shielding layer;

an over coat layer on said color filter layer.

55. The multi-domain liquid crystal display device according to claim 53 or 54, wherein said dielectric frame maintains uniformly gap between said first and second substrates.

56. The multi-domain liquid crystal display device according

to claim 53, 54 or 55, wherein said dielectric frame shields light leakage from a region other than said pixel region.

57. The multi-domain liquid crystal display device according to any one of claims 53 to 56, wherein said dielectric frame includes mixture of acrylic resin and carbon black.

58. The multi-domain liquid crystal display device according to any one of claims 53 to 57, wherein said pixel electrode has an electric field inducing window inside of itself.

59. The multi-domain liquid crystal display device according to any one of claims 54 to 58, wherein said passivation layer has an electric field inducing window inside of itself.

60. The multi-domain liquid crystal display device according to any one of claims 54 to 59, wherein said gate insulator has an electric field inducing window inside of itself.

61. The multi-domain liquid crystal display device according to any one of claims 53 to 60, wherein said common electrode has an electric field inducing window inside of itself.

62. The multi-domain liquid crystal display device according to any one of claims 54 to 61, wherein said color filter layer has an electric field inducing window inside of itself.

63. The multi-domain liquid crystal display device according to any one of claims 54 to 62, wherein said over coat layer has an electric field inducing window inside of itself.

64. The multi-domain liquid crystal display device according to any one of claims 53 to 63, wherein said pixel region is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being driven differently from each other.

65. The multi-domain liquid crystal display device according to any one of claims 53 to 64, wherein said alignment layer is divided into at least two portions, liquid crystal molecules in said liquid crystal layer in each portion being aligned differently from each other.

66. A multi-domain liquid crystal display device comprising:

first and second substrates facing each other;

a liquid crystal layer between said first and second substrates;

a plurality of gate bus lines arranged in a first direction on said first substrate and a plurality of data bus lines arranged in a second direction on said first substrate to define a pixel region;

a pixel electrode in said pixel region;

a dielectric frame surrounding said pixel region, said dielectric frame distorting electric field applied to said liquid crystal layer;

a common electrode on said second substrate; and

an alignment layer on at least one substrate between said first and second substrates.

67. The multi-domain liquid crystal display device according to claim 66, further comprising;

a gate insulator over said whole first substrate;

a passivation layer on said gate insulator over said whole first substrate;

a light shielding layer on said second substrate;

a color filter layer on said light shielding layer;

an over coat layer on said color filter layer.

68. The multi-domain liquid crystal display device according to claim 66 or 67, wherein said dielectric frame shields light leakage from a region other than said pixel region.

69. A multi-domain liquid crystal display device substantially as hereinbefore described with reference to and/or substantially as illustrated in any one of or any combination of Figs. 3A to 38B of the accompanying drawings.

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Application No:	GB 9924711.6	**Examiner:**	Iwan Thomas
Claims searched:	1 - 69	**Date of search:**	25 November 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G5C CHG, G2F FCD

Int Cl (Ed.6): G02F 1/1339, 1/1343, 1/136

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2321718 A	(NSC) See page 3 lines 15 - 20	1, 24, 25, 36, 41, 45, 50, 53 & 66
X	GB 2296810 A	(SAMSUNG) See fig. 2A & 2B	1, 24, 25, 36, 41, 45, 50, 53 & 66
A	EP 0854377 A2	(SHARP) See page 5 lines 51-58, and page 6 lines 1-2	1, 24, 25, 36, 41, 45, 50, 53 & 66
X	EP 0752611 A2	(OIS) See abstract	1, 24, 25, 36, 41, 45, 50, 53 & 66
A	US 5309264	(IBM) See all figs. and col. 3 lines 49-68 and col. 4 lines 1-19.	1, 24, 25, 36, 41, 45, 50, 53 & 66

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		

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Application No: GB 9924711.6
Claims searched: 1 - 69

Examiner: Iwan Thomas
Date of search: 25 November 1999

Category	Identity of document and relevant passage		Relevant to claims
A	US 4978203	(SEMICONDUCTOR ENERGY LAB.) See fig. 1 and col. 2 lines 5-9	1, 24, 25, 36, 41, 45, 50, 53 & 66
X	US 4937566	(COMMISARIAT A L'ENERGIE ATOMIQUE) See fig. 10 and col. 5 lines 53-61	1, 24, 25, 36, 41, 45, 50, 53 & 66
X	US 4581608	(GEC) See fig. 1a	1, 24, 25, 36, 41, 45, 50, 53 & 66
A	JP 9197420	(NEC) See abstract and fig.	1, 24, 25, 36, 41, 45, 50, 53 & 66

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
Y Document indicating lack of inventive step if combined with one or more other documents of same category.	P Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application.

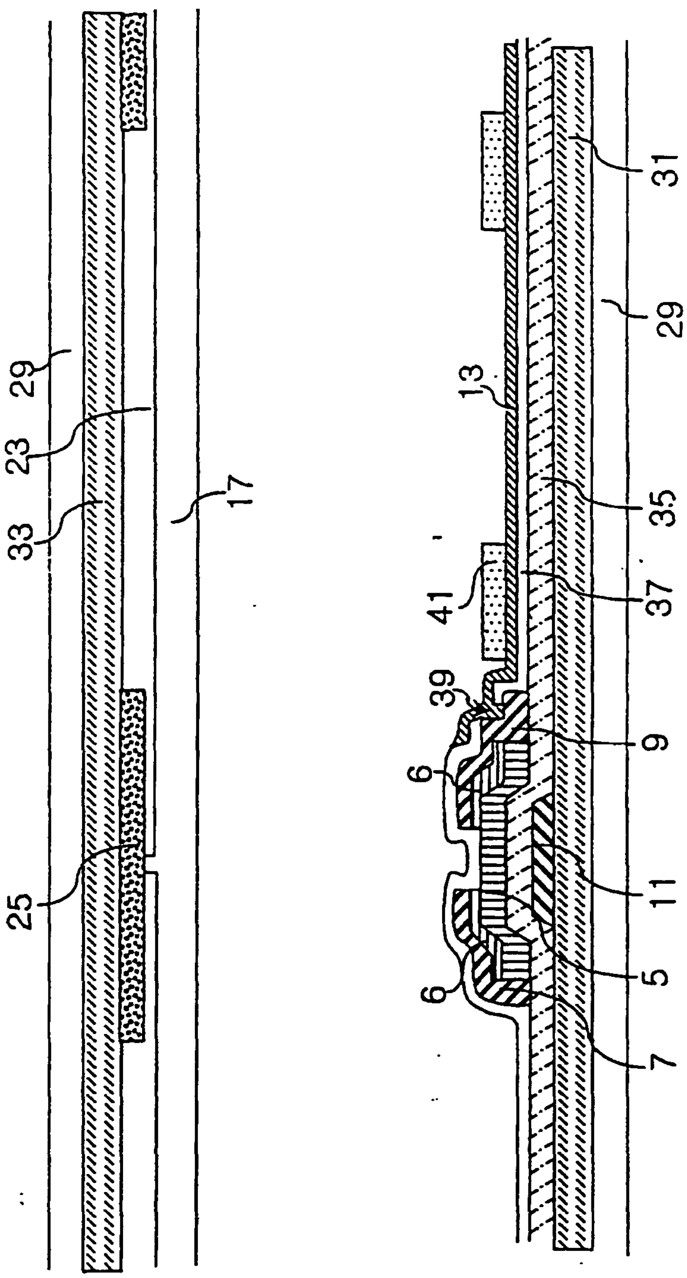

Fig. 3A